

CITY OF CHICAGO 2012 BICYCLE CRASH ANALYSIS

SUMMARY REPORT and Recommendations





Dear Fellow Chicagoans:

Making our streets safer for bicycling will benefit all Chicagoans even if they don't currently ride a bike. Everyone should feel safe on our City's streets, from an eight-year-old learning to ride a bike for the first time to an eighty-year-old who wants to ride to the store. To achieve this goal, it is essential for us to look at all of the factors that contribute to the safety of bicyclists on our streets, and to take the opportunity to make our streets safer for pedestrians and auto users at the same time.

The Chicago Bicycle Crash Analysis looks at all aspects of bicycle crashes in the city. With this report, we set out to identify all of the factors that contribute to bicycle crashes in Chicago, and then set goals for improvement. The period of study (2005-2010) gives us a clear picture of what we need to achieve the goals of Chicago's Bike 2015 Plan and the Streets for Cycling Plan 2020.

The following report lays out benchmarks for various types of crash data and information. Locations, time of day, gender and weather are just a few of the elements and factors we looked at to analyze crashes in Chicago. At the end of the report, you will find a comprehensive set of recommendations for improvements to our bike network and our reporting mechanisms that will work to improve bicycling for all Chicagoans and visitors alike.

Ride safe,

Gabe Klein, Commissioner
Chicago Department of Transportation

CITY OF CHICAGO 2012 BICYCLE CRASH ANALYSIS

2005-2010 Crash Data
Summary Report
and Recommendations

Made possible through a grant by the
Illinois Department of Transportation





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INTRODUCTION

The City of Chicago has long enjoyed a reputation as one of the best large cities for bicycling in the United States. Through a combination of visionary leadership, thoughtful planning, inter-agency cooperation and dedicated resources, Chicago has created an impressive network of bicycle facilities that reach every corner of the City. Residents currently enjoy a growing network of over 170 miles of on-street bike facilities, quality off-street paths (including the 18.5-mile Lakefront Trail), over 13,000 bike racks and sheltered high-capacity bike parking at many Chicago Transit Authority rail stations. Chicago's Bicycling Ambassadors and other outreach and training programs are among the most robust bicycle education and encouragement initiatives in the country. These investments are beginning to payoff as Chicago is in the midst of a 'bicycling renaissance'. Between 2000 and 2010, Chicago has witnessed a 150 percent increase in the number of Chicagoans bicycling to work as well as implementation of new and innovative bicycling facilities, like protected bike lanes and bike parking "corrals."



One key feature of a truly world-class bicycling city is the safety of its bicyclists. Bicycle crashes in Chicago remain a serious concern. In the six-year period between 2005 and 2010, there were nearly 9,000 injury crashes involving bicyclists, with 32 bicyclist fatalities. As a percentage of all traffic crashes, bicycle crashes are on the rise: from 6.7 percent of all crash types in 2005 to 9.8 percent of all crash types in 2010. Perhaps the most important point to be made is that with proper street design and behavior change amongst road users, **the overwhelming majority of bicycle crashes are preventable.**

In May 2012, the Chicago Department of Transportation (CDOT) launched *Chicago Forward*, a 2-year action agenda for improving the way Chicagoans get around. *Chicago Forward* establishes two goals that are directly focused on bicycle safety: reduce pedestrian and bicycle crash injuries, each by 50 percent within 5 years and increase the total number of adults and children who receive in-person safety education by 5 percent annually. As stated by Mayor Rahm Emanuel:

"One of my top priorities as mayor is to create a bike network that allows every Chicagoan - from kids on their first ride to senior citizens on their way to the grocery store - to feel safe on our streets."

For these reasons and more, the City created this Chicago Bicycle Crash Analysis. The purpose of this report is threefold: 1) to analyze bicycle crashes in the City of Chicago; 2) to identify key areas of concern and 3) to recommend strategies that address these areas of concern, in order to reduce crashes. As bicycling in Chicago continues to grow, the City of Chicago - including its agencies, staff and elected officials - is more committed than ever to making bicycling safer and more accessible for all residents.



To complete this report, multiple sources of information were utilized. The data used were of two different types: 1) safety data on crashes, injuries and trauma from several sources including the Illinois Department of Transportation (Motor Vehicle Crash File 2005 to 2010 and Dooring Data 2010 to 2011), National Highway Traffic Safety Administration (Fatality Analysis Reporting System), local police reports and the American College of Surgeons (National Trauma Data Bank); and 2) travel trend data to identify patterns in bicycle use from the U.S. Census Bureau (American Community Survey 2005 to 2010 and the Decennial Census 2010) and the Chicago Metropolitan Agency for Planning (Travel Tracker Survey 2007).

The research was conducted using summary statistics and graphical methods towards a systematic assessment of the “who”, “what” and “how” of safety risks to bicyclists with the overall goal of supporting safety initiatives and long-term bicycle planning activities. Detailed statistical analysis is left for future research.



It is also important to note the challenge of drawing conclusions from the crash data without thorough, accompanying bicycle count data. Knowing the level of exposure of bicyclists in the environment is needed in order to know the relative risk of crashes. Additionally, the number of non-motor vehicle-related crashes is not accurately reported or completely known. These questions need to be answered in future analysis.

KEY FINDINGS

EXTENT OF BICYCLING AND HOW HAS IT CHANGED

- Since 2000, the number of bicycle commuters has increased by 150 percent.
- Nationally 0.6 percent of workers commuted to work by bicycle in 2010. In Chicago, that number was 1.3 percent, or 15,000 cyclists daily.
- Among peer cities, Chicago has more bicycle commuters per capita than New York or Los Angeles, but fewer than Philadelphia or Seattle.

BICYCLE CRASH SAFETY TRENDS, 2005-2010

- From 2005 to 2010 some 32 cyclists in the City of Chicago were killed in crashes with motor vehicles.
- The number of fatal crashes decreased by 28 percent from seven in 2005 to five in 2010.
- Almost 9,000 bicyclist injury crashes occurred during the six-year period, or an average of 1,500 per year.
- The number of injury crashes increased 27 percent from 1,236 in 2005 to 1,566 in 2010.

WHERE DID CRASHES OCCUR

- Approximately 55 percent of fatal and injury crashes occurred at intersections.
- Six of Chicago's 77 Community Areas, those just north and northwest of the Loop, accounted for more than one-third of the bicycle miles traveled and one-third of the bicycle injury crashes.

WHEN DID CRASHES OCCUR

- The largest number of injury crashes occurred between 4:00 and 7:00 P.M., but fatalities were highest between 8:00 P.M. and midnight.
- There were five fatalities between 4:00 and 7:00 P.M., but nine fatalities between 8:00 P.M. and midnight.
- Approximately half of all crashes occurred during the summer months of June, July and August.
- Most bicycle crashes occurred during day light hours and in good weather.
- Sundays accounted for the highest percentage of fatalities, but the fewest percentage of bicycle injury crashes.

CHARACTERISTICS OF CYCLISTS: GENDER AND AGE

- Overall, males were three times more likely to be involved in a bicycle crash than females.
- The ratio of male to female crashes was lowest in the 20-24 age group and increased steadily with age.
- The ratio of male to female crashes was 12 times higher for males than females in the 75-84 age group.

COMPARING BICYCLE CRASHES WITH PEDESTRIAN CRASHES

- While the number of motor vehicle crashes with pedestrians declined, crashes involving bicycles increased.
- Hit and run crashes accounted for 25 percent of both injury and fatal bicycle crashes, while they accounted for 41 percent of pedestrian injury crashes and 33 percent of pedestrian fatal crashes.

ADDITIONAL FINDINGS

- The most common motorist error was failure to yield.
- The most common bicyclist error was riding against traffic.
- A helmet was known to be worn in only one fatal crash.
- Taxis were involved in 1 of 12 injury crashes.

KEY RECOMMENDATIONS

ROADWAY DESIGN SOLUTIONS

- Implement intersection design improvements at high crash locations.
- Expand the network of protected bike lanes.
- Institute traffic calming techniques to slow speeds at severe crash locations.

EDUCATION AND MARKETING SOLUTIONS

- Enhance motorist and bicyclist direct education programs.
- Expand targeted enforcement outreach.
- Create broad-reaching marketing campaigns targeting high risk behaviors and road users.
- Expand commercial vehicle operator training.
- Institute enhanced driver education.

DATA AND REPORTING SOLUTIONS

- Collect comprehensive, multi-year bicycle counts.
- Develop mechanisms for collecting non-motor vehicle related crash data.
- Regularly update and publish bicycle crash data and implement data collection improvement strategies.
- Develop and implement outcomes evaluation for non-infrastructure initiatives .

ENFORCEMENT SOLUTIONS

- Improve police data and reporting for fatal and serious injury crashes.
- Increase the number of targeted enforcement events.

POLICY SOLUTIONS

- Improve inter-agency partnerships and collaboration.
- Fully implement the Child Safety Zone initiative near schools and parks.



BICYCLE SAFETY PROGRAMS IN CHICAGO

Beginning in 1992 with the publication of the Bike 2000 Plan, the City of Chicago has consistently demonstrated its commitment to enabling and encouraging bicycling as a safe, healthy, environmentally-friendly and fun way to travel. Over the last two decades, the Chicago Department of Transportation's Bicycle Program has developed a robust, multi-faceted approach to creating a better bicycling environment for the public. CDOT's Bicycle Program focuses on a mix of infrastructure and programmatic approaches for improving the bicycling experience in Chicago. Current initiatives include:

- On-street bikeway installation
- Multi-use trail development
- Bicycle rack installation
- Bicycling and Pedestrian Ambassadors and Junior Ambassadors Programs
- Share the Road Outreach events (in partnership with the Chicago Police Department and Chicago's Aldermanic Offices)
- Training videos and curricula for taxi drivers, Chicago Transit Authority bus operators and Chicago Police Academy cadets
- Bicycle safety publications
- Chicago Bike Map
- Mayor's Bicycle Advisory Council

Chicago is fortunate to have the support of other City, County, Regional and State agency partners that also prioritize and promote bicycling and bicycle safety, including:

- Chicago Transit Authority (CTA), Metra Rail and Pace Suburban Bus Service
- Chicago Park District and The Forest Preserve District of Cook County
- Chicago Police Department Bicycle Registry
- Chicago Department of Cultural Affairs and Special Events' Bike Chicago Initiative
- Chicago Metropolitan Agency for Planning
- Cook County Highway Department
- Illinois Department of Transportation

Under the leadership of Mayor Rahm Emanuel and Department of Transportation Commissioner Gabe Klein, CDOT's Bicycle Program stands poised to enter a new era for bicycling in the City, moving toward bicycling as a mainstream transportation mode for all Chicagoans. The road map for the future of bicycling in Chicago is outlined in a number of long-term plans and documents, including:

- Chicago Forward: Department of Transportation Action Agenda
- Chicago Bike 2015 Plan
- Streets for Cycling 2020 Plan
- Bike Share Program
- Chicago Complete Streets Design Guide





Trends in Bicycle Crashes



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Trends in bicycle crashes and rates

GROWTH IN CYCLING

A better understanding of bicycle crash data requires an assessment of the growing popularity of bicycling. The most reliable source of mode share data is the U.S. Census Bureau which reports the number of commuters by mode of transportation. This data shows that the number of workers commuting to work by bicycle increased from 5,956 to 15,096 between 2000 and 2010 (Figure 2). Since 2000, Chicago's bicycle commuter mode share more than doubled, from 0.5 percent to 1.3 percent. Further, the City of Chicago accounted for only 21 percent of all Illinois commuters, but 39 percent of the state's walkers and 42 percent of those who bicycle to work.

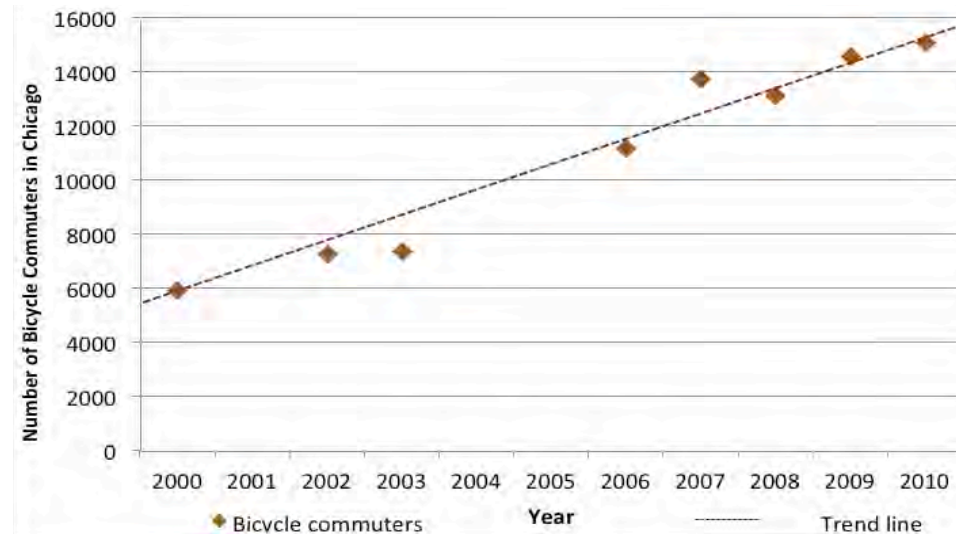
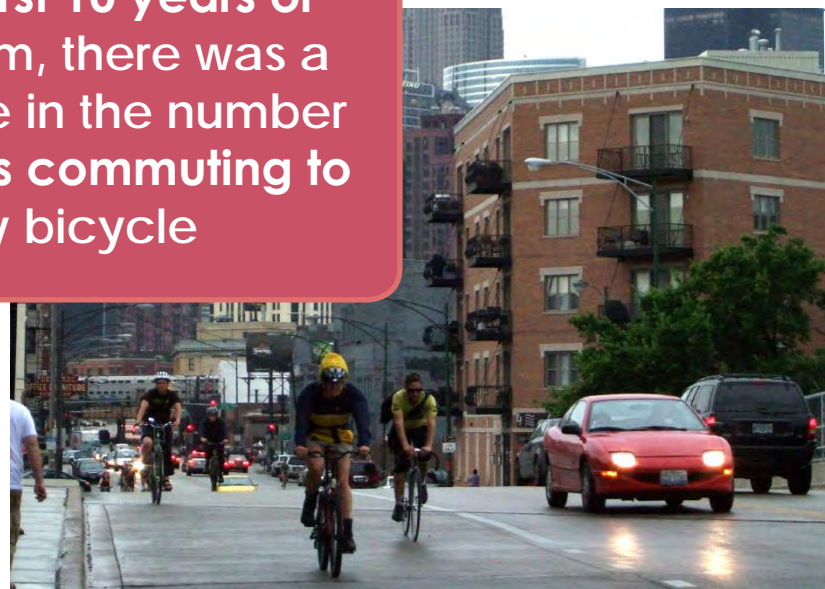


Figure 2: Number of daily bicycle commuters, City of Chicago, 2000-2010



During the first 10 years of this millennium, there was a 150% increase in the number of Chicagoans commuting to work by bicycle



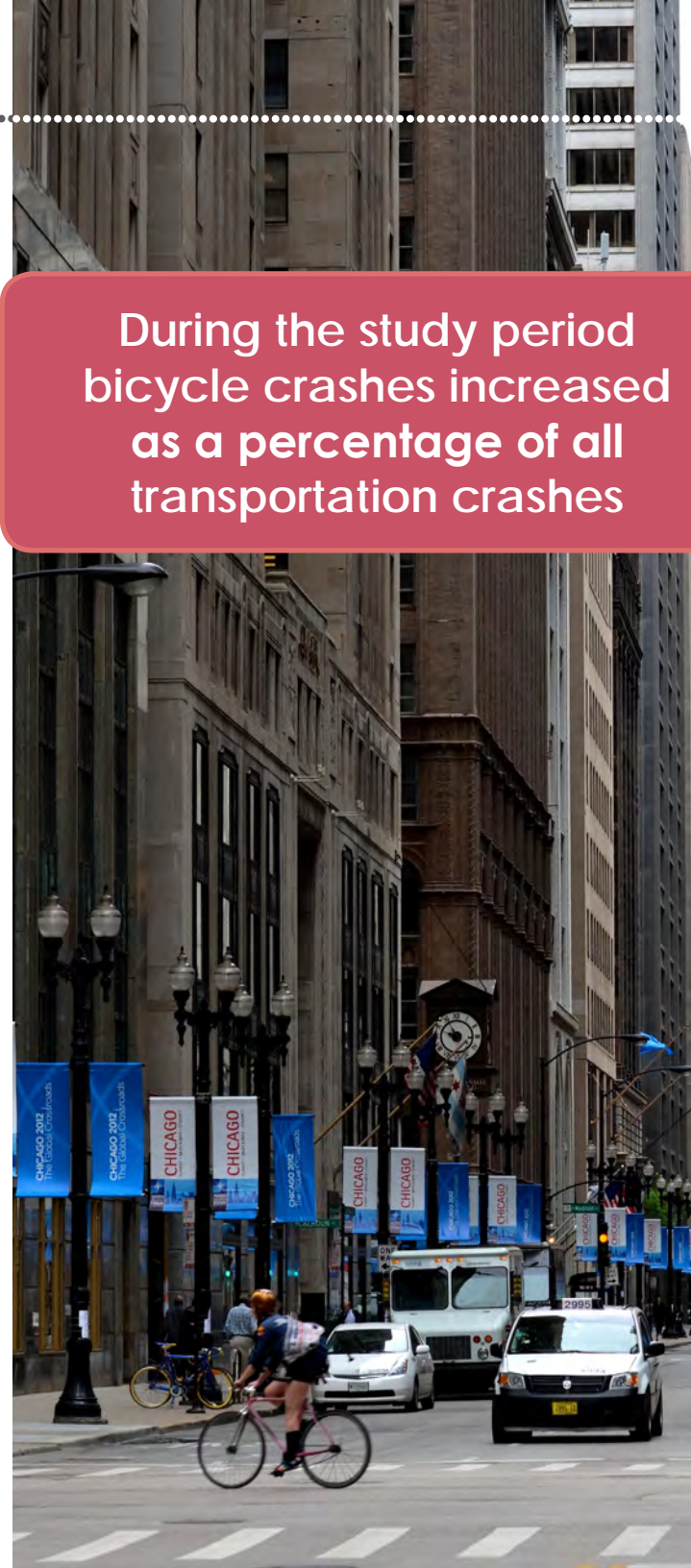
FATAL AND INJURY CRASHES

From 2005 to 2010 there were a total of 32 fatal bicycle crashes and 8,861 injury crashes. Injury crashes are categorized as A, B and C, with Type A crashes representing incapacitating injury, Type B representing non-incapacitating but serious injury, and Type C crashes being the least serious with only the possibility of injury. The number of fatalities dropped from seven in each of the first two study years to five in each of the latter three years (Table 1). During this period, fatalities in all modes of travel declined in Chicago and the bicycle-crash percentage of all crashes has remained at about three to four percent. During the study period bicycle injury crashes showed an overall increase from 2005 to 2010. The highest number was in 2007 and the lowest number was in 2005 with the number of crashes in 2006 and 2009 being essentially the same. Most importantly, bicycle injury crashes as a percent of all transportation injury crashes show signs of an increasing trend from less than seven percent in 2005 to about ten percent in 2010.

	Mode	2005	2006	2007	2008	2009	2010	TOTAL
Fatal Crashes	Bicycle	7	7	3	5	5	5	32
	All Modes	179	176	164	156	141	127	943
	Percent of all Modes	4%	4%	2%	3%	4%	4%	3%
Injury Crashes	Bicycle	1,236	1,385	1,782	1,506	1,386	1,566	8,861
	All Modes	18,505	18,516	17,541	15,599	15,645	15,881	101,687
	Percent of all Modes	6.7%	7.5%	10.2%	9.7%	8.9%	9.9%	8.7%

Table 1: Fatal and injury crashes in the City of Chicago, 2005-2010

During the study period
bicycle crashes increased
as a percentage of all
transportation crashes





COMPARISON OF BICYCLE AND PEDESTRIAN CRASHES

The number of bicycle crashes in Chicago increased over the study period in contrast to the number of pedestrian crashes (Figure 1). The number of bicycle injury crashes peaked in 2007 while the number of pedestrian injury crashes peaked in 2006.

Bicycle injury crashes have increased by 27% while pedestrian injury crashes have declined by 9%

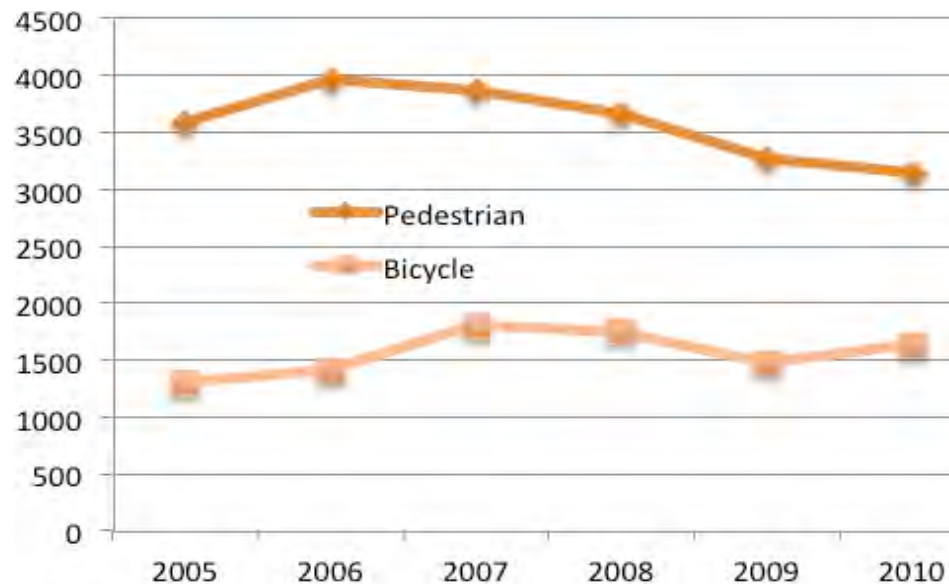
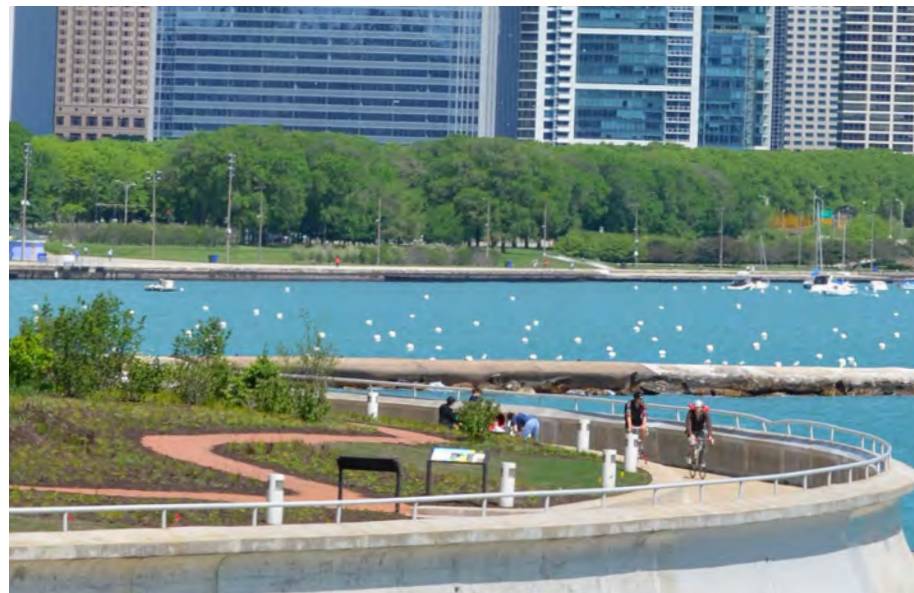


Figure 1: Pedestrian and bicycle injury crashes, 2005-2010

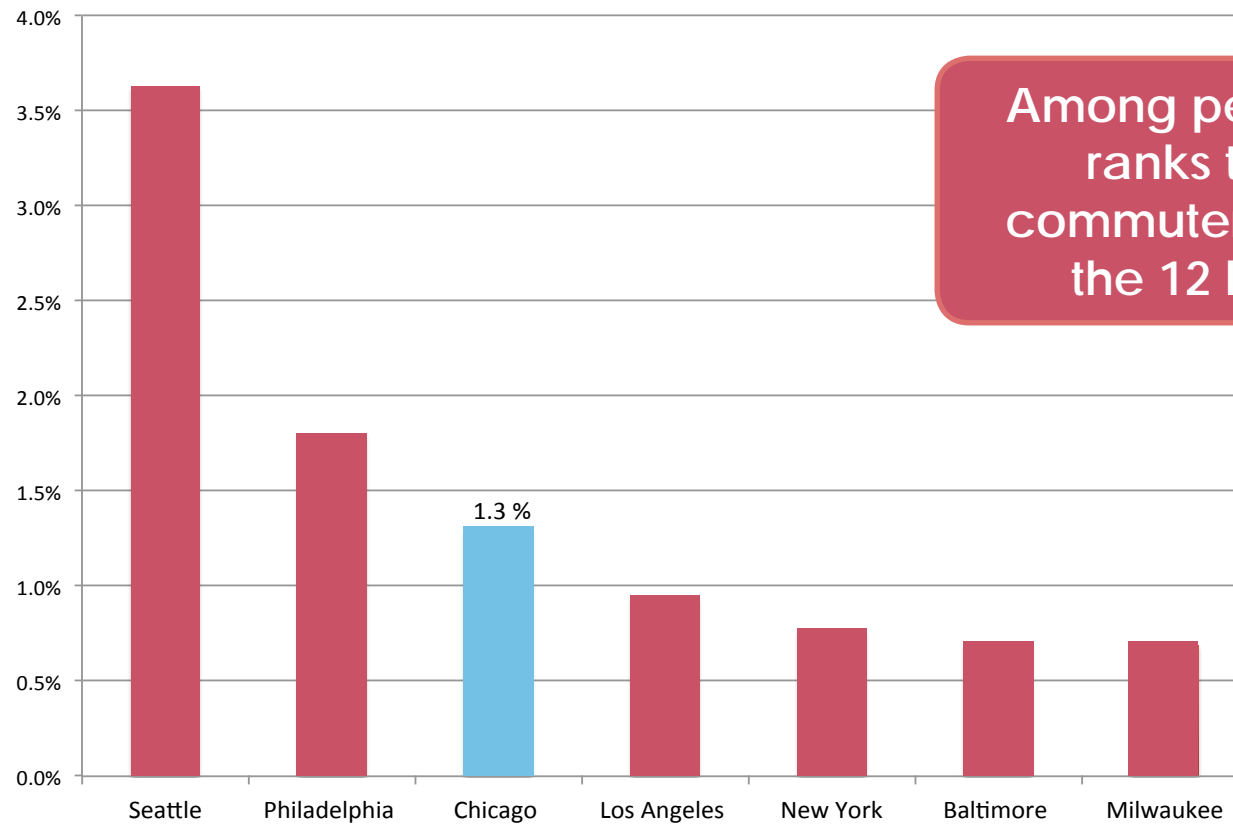






COMPARISON WITH PEER CITIES

For a meaningful comparison of crash rates, Chicago needs to be compared to cities that most resemble it in population, density and transit use. College towns were not used as peer cities because they tend to have the highest proportion of commuters using bicycles, and large cities commonly have a much lower percentage. For comparison, Chicago's six peer cities were selected: Seattle, Philadelphia, Los Angeles, New York, Baltimore and Milwaukee. Chicago ranks third on propensity to use bicycles to commute amongst its peers.



Among peer cities Chicago ranks third in bicycle commuters, second among the 12 largest US cities

Figure 3: Bicyclists as a percent of all daily commuters, Peer Cities, 2010



Figure 4: Bicyclists as a percentage of all daily commuters, 12 largest cities with percentages over 0.5, 2010 (8 cities depicted)

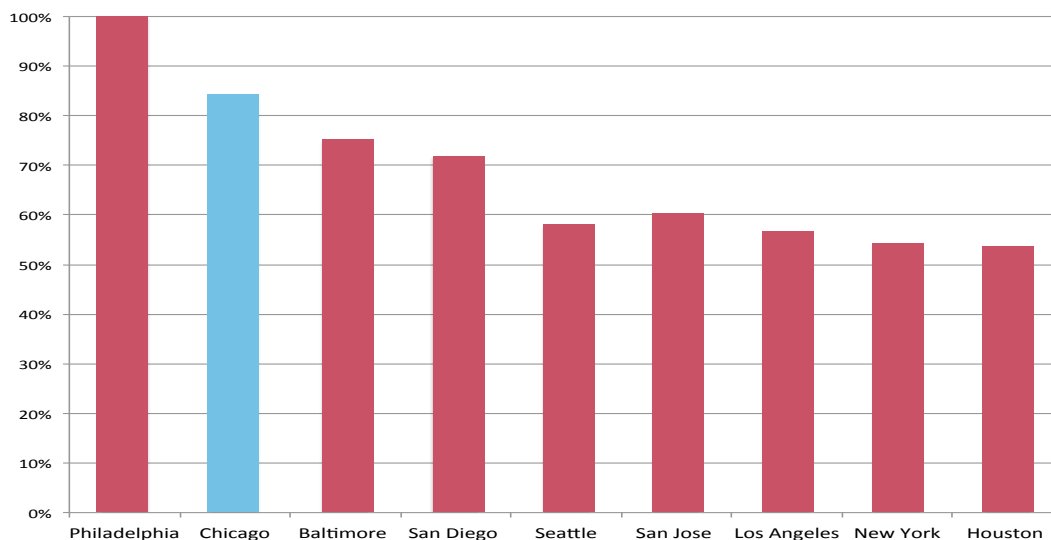


Figure 5: Highest percent increases in the proportion of commuters using bicycles among peer and largest 12 cities, 2005-2010 (9 cities depicted)

Among the twelve largest cities in the nation, eight have a 2010 bicycle mode share greater than 0.5 percent (Figure 4). Chicago's mode share ranks second highest. Cities that are among the twelve largest that are not included in Figure 4 are Houston, Jacksonville, San Antonio and Dallas. Dallas has a mode share of less than 0.2 percent.

The percent change in the mode share of bicycle commuters during the study period is shown in Figure 5. Nine of the twelve largest cities are depicted. On this measure, Philadelphia's mode share doubled and Chicago's increased by 84 percent. Indianapolis and San Antonio also had large percentage increases but were not included as their base mode share was only 0.1 percent and a modest increase resulted in a high percentage increase. Dallas, Jacksonville and Phoenix all show decreases, though the decreases may be statistically insignificant.

Chicago ranks second among large and peer cities in percent increase in commuting by bicycle

A group of cyclists are riding on a city street. In the background, a white bus is visible with the destination '50 UHLEN TO' on its display. A 'NO TURN ON RED' sign is mounted on a pole. The scene is set in an urban environment with brick buildings and a clear sky.

Cyclist & Motorist Characteristics



<i>Gender of cyclists</i>	20
<i>Age of cyclists</i>	21
<i>Gender and age of motorists</i>	22



Cyclist characteristics

GENDER OF CYCLISTS

Males account for approximately two-thirds of all miles cycled by Chicago residents but account for three-quarters of injury crashes and have twice the fatality rate as females (Table 2). However, males experienced 40 percent more injury crashes per mile cycled (the miles cycled are derived from a dataset with a moderately small sample).

	Share of Miles Cycled	Percentage Injured	Fatalities per 100 Million Miles	Injury Crashes per 100 Million Miles
Female	31%	25%	2.8	1,000
Male	69%	75%	5.5	1,400
Ratio	2.2	3	2	1.4
Total	100%	100%	4.6	1,300

Table 2: Injuries and fatalities by miles cycled (miles estimated from CMAP Travel Tracker data, 2007)



Males bike more than females and had proportionately higher rates of injury crashes





Males ages 10-14 and 45-54 had a disproportionately greater number of crashes

AGE OF CYCLISTS

At every age, except for cyclists less than five years old, males had more injury crashes compared to females. Males aged 10-14 and 45-54 appeared to have a disproportionately greater number of crashes than females (Figure 6). Those 20-24 years old have the greatest likelihood of being involved in crash.

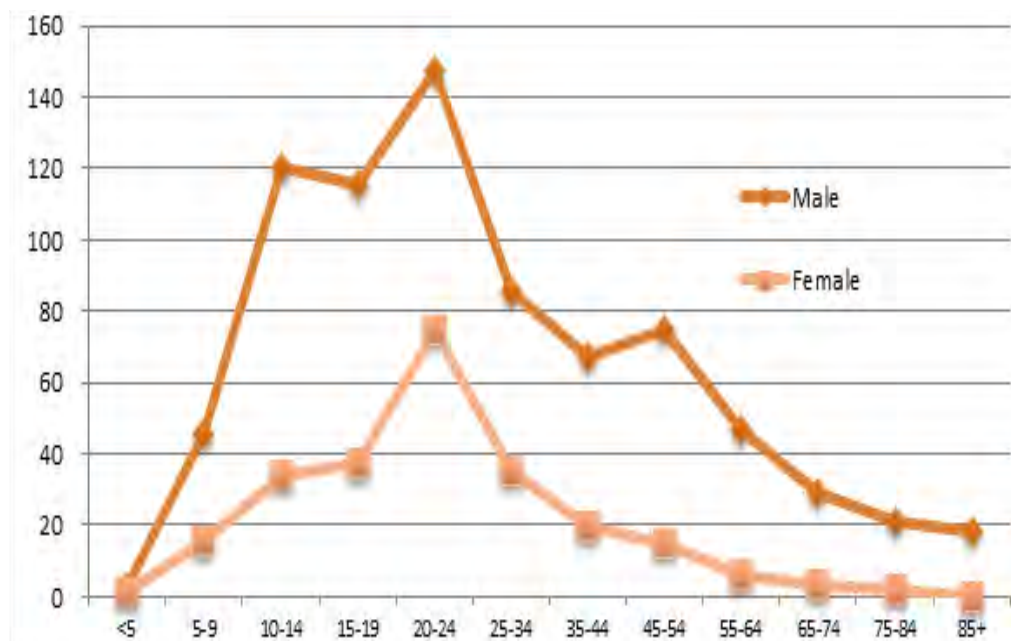


Figure 6: Annual average injury crash rate by age per 100,000 residents



GENDER AND AGE OF MOTORISTS

More crashes involved male drivers than female. Male motorists were involved in approximately 64 percent of injury crashes (Table 3) and accounted for an even greater percent of fatal bicycle crashes (70 percent, Table 4). For both male and female drivers involved in injury crashes, over 60 percent were between the ages of 25 and 44. Females, however, accounted for the majority of fatal crashes for drivers aged 55 and older.

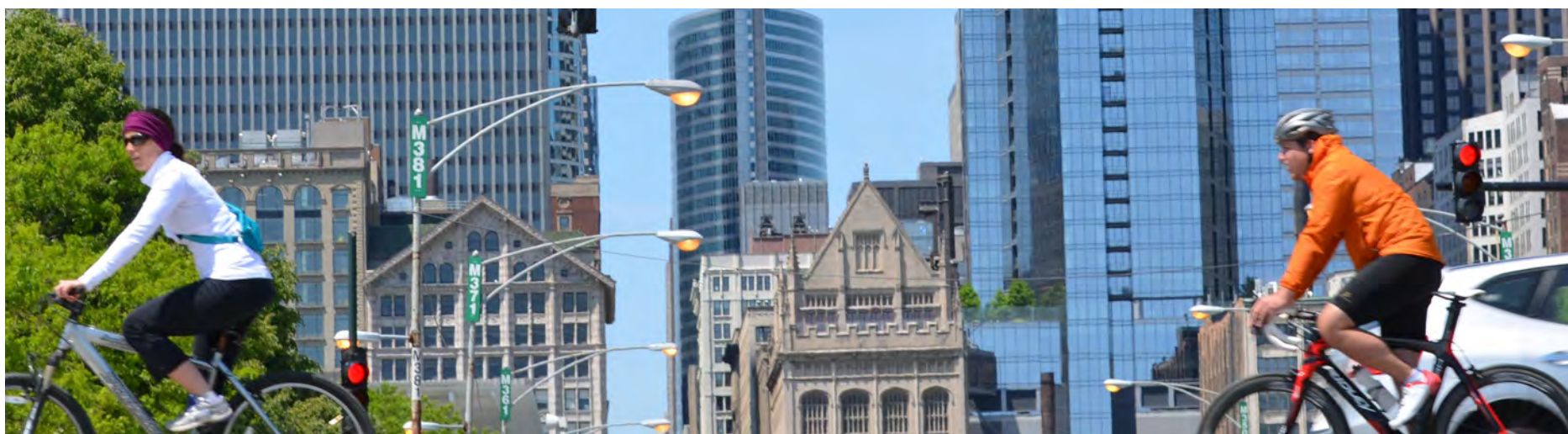
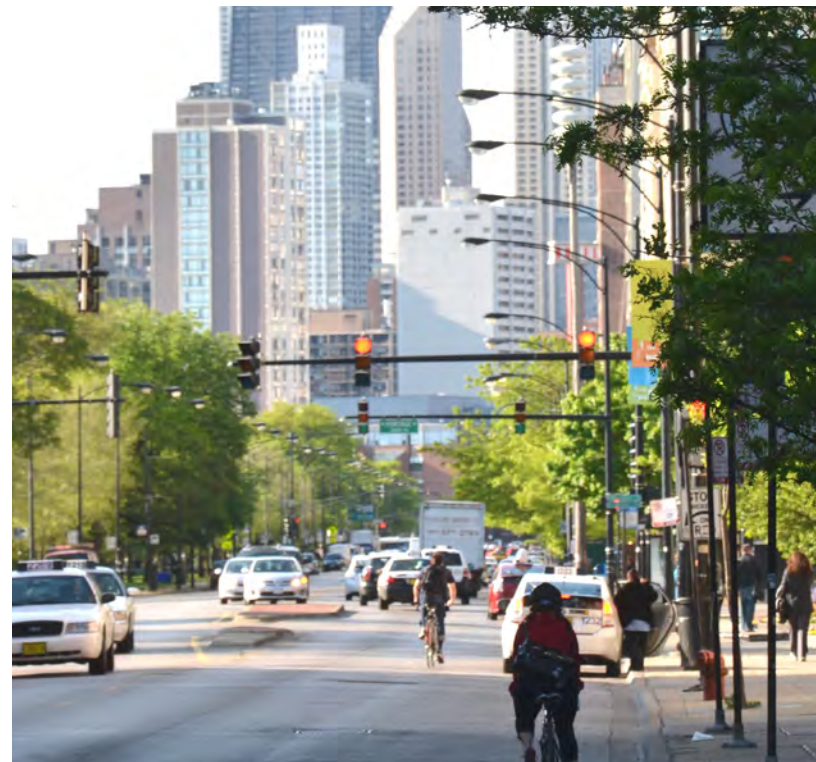


	Injury Crashes	Percentage of Injury Crashes	Percentage of Known Injury Crashes
Male	4441	49.9%	63.9%
Female	2508	28.1%	36.1%
Unknown	1962	22.0%	-

Table 3: Gender of drivers involved in bicycle injury crashes

Age	Male Motorists	Female Motorists	Total	Percent
15-24	3	0	3	11.1%
25-34	3	4	7	25.9%
35-44	9	1	10	37.0%
45-54	3	0	3	11.1%
55-64	1	3	4	14.8%
65+	0	0	0	0.0%
Total	19	8	27	
Percent	70%	30%	100%	

Table 4: Age of drivers involved in fatal bicycle crashes



Vehicles & Operators





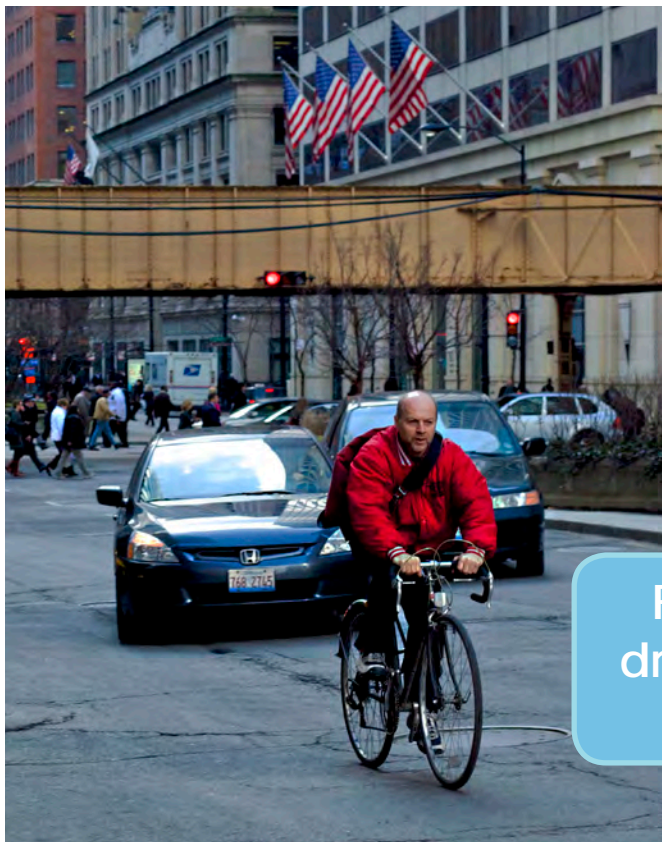
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<i>Dooring</i>	29
<i>Helmet use</i>	30
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Motorist characteristics

MOTORIST ACTION

Drivers' Failure to yield the right of way is a major contributing factor to bicycle crashes. These crashes accounted for approximately 40 percent of the bicycle injury crashes (Table 8) as well as fatal crashes.



Failure to yield by a driver occurred in 40% of bicycle crashes

Cause of Crash	Year							
Driver action	2005	2006	2007	2008	2009	2010	Total	Percent
None	360	390	477	368	358	431	2,384	35.3%
Failed to yield	357	385	551	452	463	525	2,733	40.5%
Disregarded control devices	21	38	34	26	25	14	158	2.3%
Improper turn	15	23	24	35	27	33	157	2.3%
Other	196	230	254	235	203	205	1,323	19.6%
Total	949	1,066	1,340	1,116	1,076	1,208	6,755	100%

Table 8: Driver action in bicycle injury crashes, 2005-2010

BICYCLIST ACTION

Approximately 40 percent of the bicycle injury crashes occurred when the bicyclist was traveling with traffic (Table 9) and 10 percent when the bicyclist was traveling against traffic. At signalized intersections, however, nearly twice as many crashes occurred when bicyclists were crossing against the traffic signal.



10% of bicycle crashes occurred when a bicyclist traveled against traffic

Bicyclist Action	Injury Type			Total	Percent
	A - Incapacitating	B - Non-incapacitating	C - Possible injury		
Walking/riding with traffic	288	1,624	1,084	2,996	40.40%
Crossing – with signal	91	505	372	968	13.05%
Walking/riding against traffic	94	374	296	764	10.30%
Crossing – against signal	69	275	185	529	7.13%
Enter from drive/alley	33	209	147	389	5.25%
Other	87	483	382	952	12.84%
Total	751	3,857	2,807	7,415	100%

Table 9: Bicyclist action in bicycle injury crashes, 2005-2010



VEHICLE TYPE AND USE

Passenger cars were involved in the majority of bicycle crashes (Table 6). Sports utility vehicles (SUVs) and vans were the second and third most common vehicles involved in bicycle crashes. Of these three predominant types of vehicles, only the SUVs crash rates increased during the 2005-2010 period from 87 to 165.

Most of the vehicles involved in bicycle crashes were used for personal travel purposes (Table 7). Taxis ranked second with buses third. Taxis and for-hire uses accounted for approximately 1 in 12 crashes. City buses were involved in 1.6 percent of all bicycle crashes.

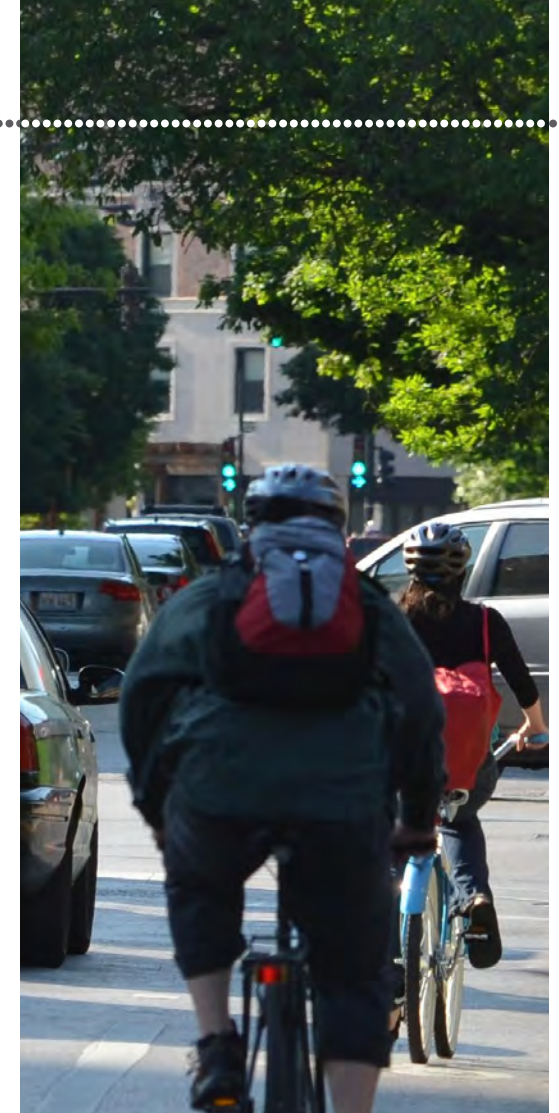
Vehicle Type	2005	2006	2007	2008	2009	2010	Total	Percent
Passenger car	880	921	1167	980	937	1,109	5,994	74.2%
SUV	87	91	122	120	130	165	715	8.8%
Van/mini-van	93	100	103	82	83	106	567	7.0%
Other	119	120	155	133	119	160	806	10.0%
Total	1,179	1,232	1,547	1,315	1,269	1,540	8,082	100%

Table 6: Vehicle type involved in bicycle injury crashes, 2005-2010

Vehicle Type	2005	2006	2007	2008	2009	2010	Total	Percent
Personal	810	846	1,084	885	855	1,024	5,504	78.4%
Taxi/for hire	80	91	110	114	90	107	592	8.4%
City bus	19	15	23	11	13	31	112	1.6%
Other	123	120	159	141	131	142	816	11.6%
Total	1,032	1,072	1,376	1,151	1,089	1,304	7,024	100%

Table 7: Vehicle use during crash, 2005-2010

Citywide, taxis were involved in 8.4% of bicycle crashes and 6.7% of pedestrian crashes



DOORING

The term 'dooring' applies to incidents in which the cyclist is riding in a legal place and a person in a stationary vehicle opens their door causing a crash. These crashes can result in serious injuries. In particular, Type B non-incapacitating injury crashes occur more frequently in dooring crashes (Table 11).

At the time of this analysis there was insufficient overlapping bicycle crash and dooring data to report the percentage of crashes due to dooring. Comprehensive bicycle crash data are available through 2010, while dooring data are available only for 2010 and 2011.

Injury Type	Non-dooring crashes	Dooring crashes
A - Incapacitating	11%	8%
B - Non-incapacitating	51%	61%
C - Possible injury	38%	31%

Table 11: All crashes vs. dooring bicycle crashes, by injury type

Collectively, Type A and B injuries were proportionately higher in dooring crashes





Motorist characteristics

HELMET USE

In the 29 fatal crashes for which we have helmet use information, only one of the bicyclists is known to have been wearing a helmet. It is important to note that data from the remaining reports did not indicate clearly whether or not a helmet was worn. For this reason, this report cannot accurately analyze the impact of helmet use in fatal crashes in Chicago. However, national data indicates that only 25 percent of cyclists taken to trauma centers were wearing helmets.

Only one fatally injured cyclist is known to have worn a helmet



HIT AND RUN

Twenty-five percent of all bicycle crashes were hit and run crashes, where the motorist failed to remain at the crash scene. This is considerably lower than the proportion of pedestrian injury and fatal automotive hit and run crashes (Table 5). Even though there were only half as many hit and run crashes for bicyclists as there were for pedestrians, there was 1 hit and run bicycle crash on average every day.

Hit and run crashes	Fatal crashes	Injury crashes
Bicycle crashes	25%	25%
Pedestrian crashes	40%	33%

Table 5: Hit-and-run crashes as a percentage of all crashes

On average, there was 1 hit and run bicycle crash per day

25% of bicycle crashes were hit and runs





Motorist characteristics

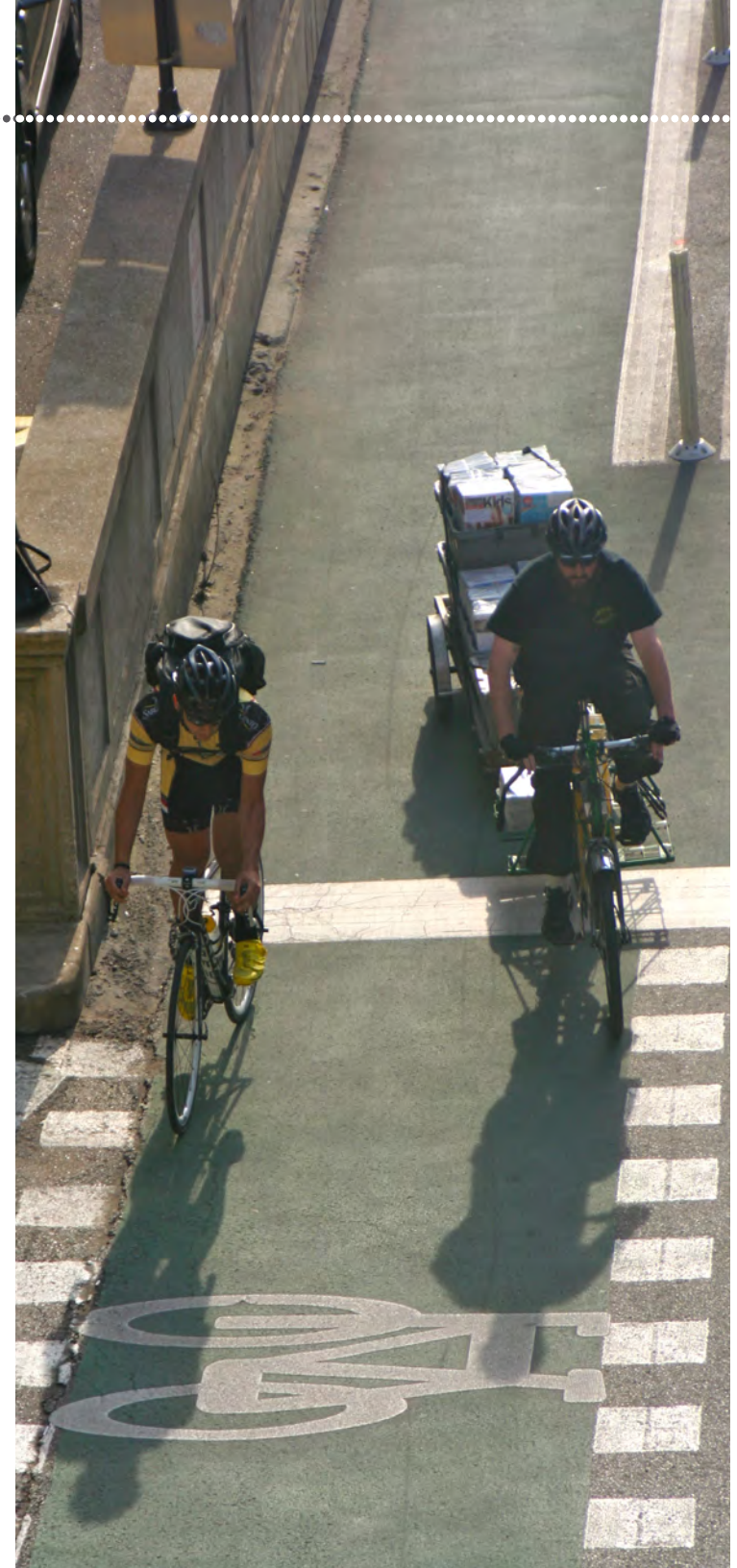
14.8% of bicyclists in fatal crashes were over the legal limit for blood alcohol content



ALCOHOL

Of the drivers involved in fatal crashes, six were tested for alcohol and one refused. Four did not have alcohol in their system and the two that did had levels less than the legal limit of 0.08. Of the 27 bicyclist fatalities for which Blood Alcohol Content (BAC) is available, eight bicyclists showed measurable alcohol in their system. Four had levels over 0.08, the legal limit for motor-vehicle drivers in Illinois. Using 0.08 as a benchmark, the percentage for bicyclists riding under the influence is 14.8 percent. This compares to 32 percent for motor-vehicle fatalities in the U.S. and 35 percent in Illinois in 2009.





When Did Bicycle Crashes Occur

A photograph of a bicycle with a black frame and red wheels leaning against a tree. The background features a brick wall and a large tree, with the scene illuminated by the warm, golden light of a sunset or sunrise. The sky is a mix of orange and blue. The bicycle is positioned in the foreground, and the tree's branches are visible in the upper left corner.



<i>Crashes by month</i>	36
<i>Crashes by day of week</i>	37
<i>Crashes by time of day</i>	38



When did bicycle crashes occur

CRASHES BY MONTH

Bicycle crashes follow a seasonal cycle, increasing sharply from February to July and declining just as quick in the fall (Figure 7). While fatal crashes peaked in the summer months, they continued to occur during the winter, from December to February.

Approximately 45% of the injury and fatal crashes occurred during the summer

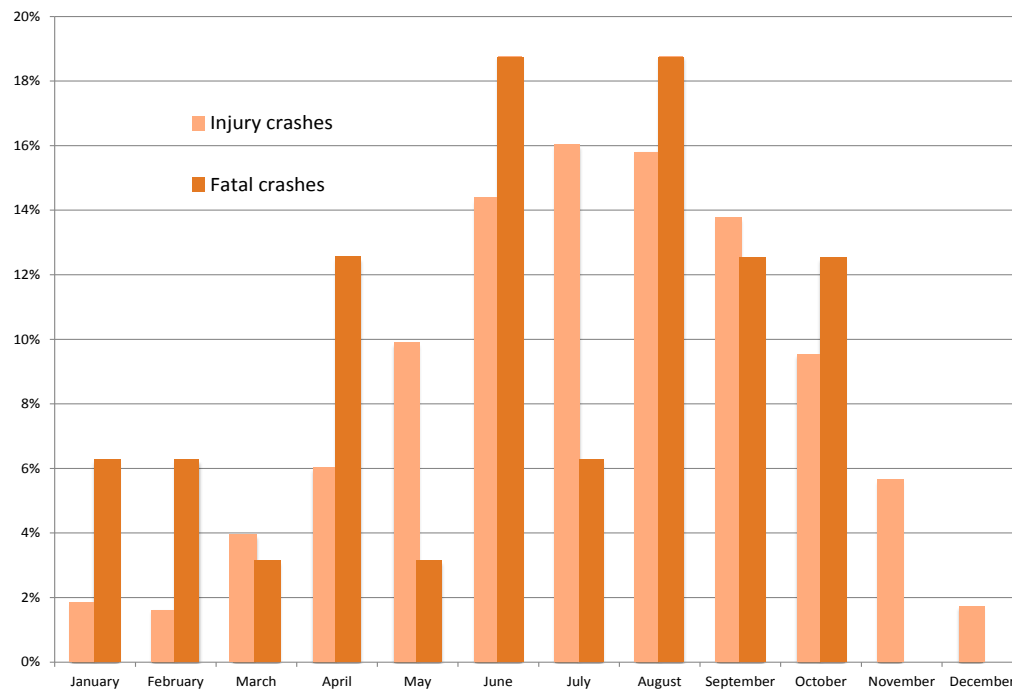


Figure 7: Fatal and injury crashes by month, 2005 to 2010



CRASHES BY DAY OF WEEK

While there are no large differences between weekdays, injury crashes tended to occur to a greater degree on Friday. Friday had the highest percentage of serious crashes and collectively the largest percentage of overall crashes (Figure 8). Sunday had the fewest crashes, perhaps a reflection of overall lower roadway usage levels by both bicycles and cars. Saturday is the second lowest day, but not noticeably different than Monday.

While Sunday had the smallest percentage of crashes, it also had the largest percentage of fatal bicycle crashes at seven. Of the seven, four occurred during darkness. While this may be attributable to idiosyncrasies associated with the small percentage of fatalities during the study period it merits further study.

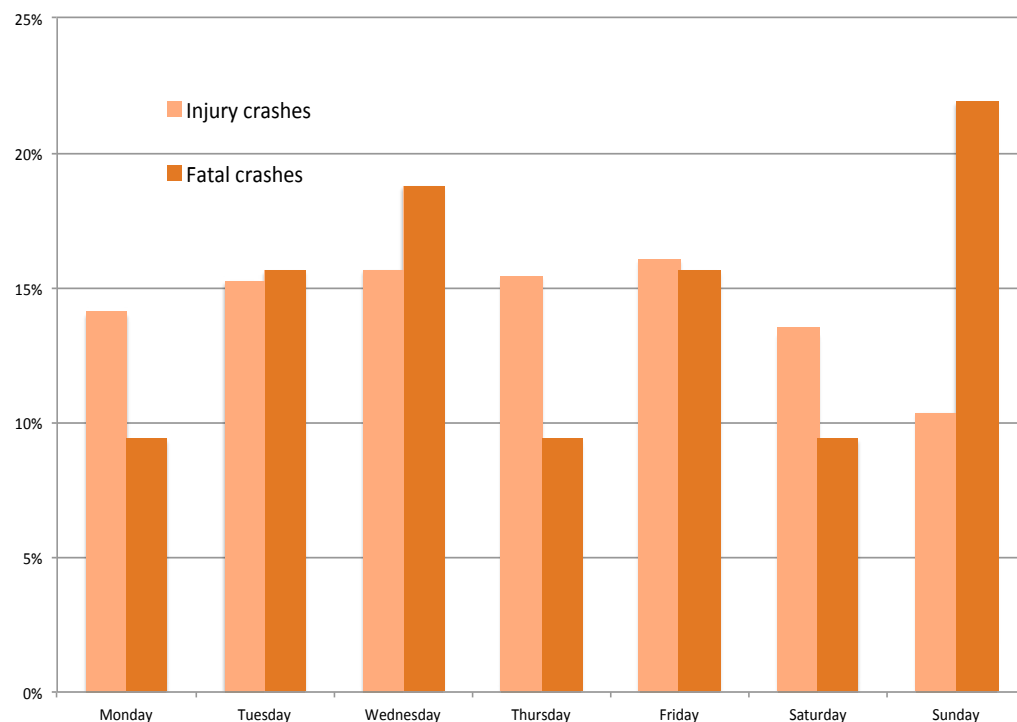


Figure 8: Fatal and injury crashes by day of week, 2005-2010





When did bicycle crashes occur

CRASHES BY TIME OF DAY

The percentage of bicycle crashes increased throughout the day (Figure 9), with one important exception: injury crashes declined in the late evening while fatal crashes continued to increase.

An observation of Figure 9 reveals that 40 percent of injury crashes occurred between 3:00 and 8:00 P.M. However, a more detailed analysis shows that the 5:00 P.M. hour had the highest number of crashes during the day. There was also a small peak during the 8:00 A.M. hour.



A disproportionate percentage of fatalities occurred in the evening between 8:00 P.M. and midnight

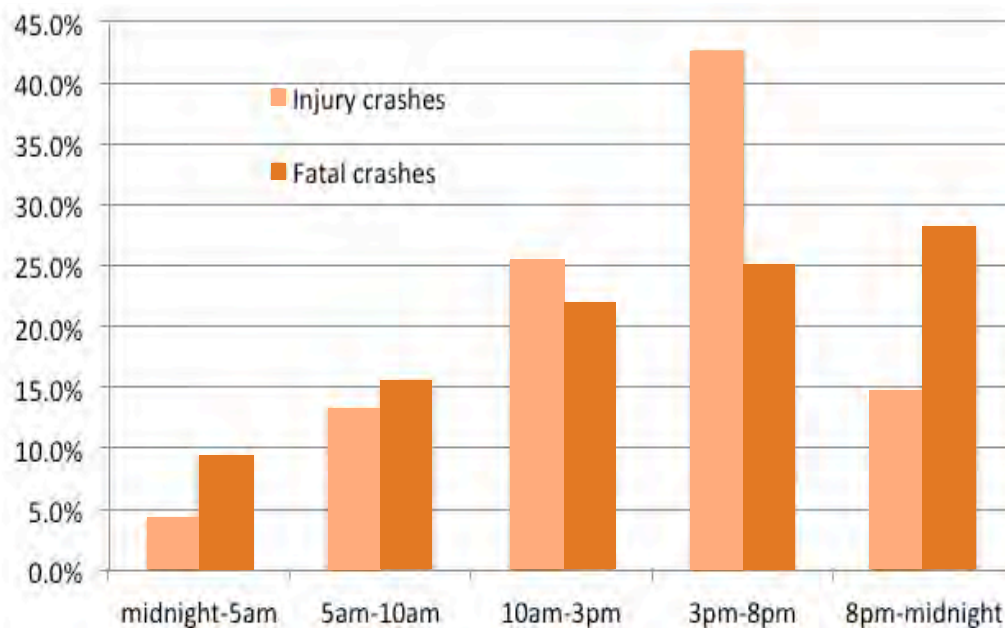
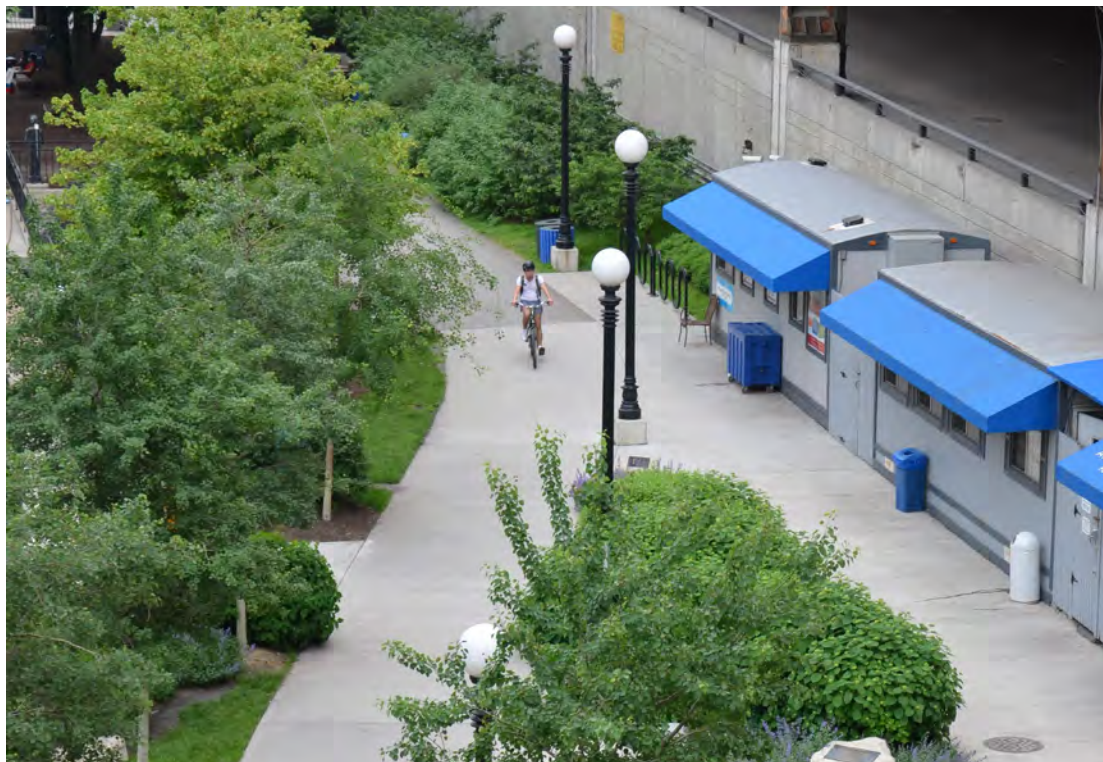


Figure 9: Fatal and injury crashes by time of day, 2005-2010





Crash Locations & Conditions





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LOCATION OF BICYCLE CRASHES

The highest number of fatal and serious bicycle injury crashes occurred in community areas north of the Loop (Figure 10). High levels of bicycle use in these areas combined with the proximity to the Loop and the lakefront may be factors.

6 of 77 Chicago community areas accounted for 1/3 of the injury crashes

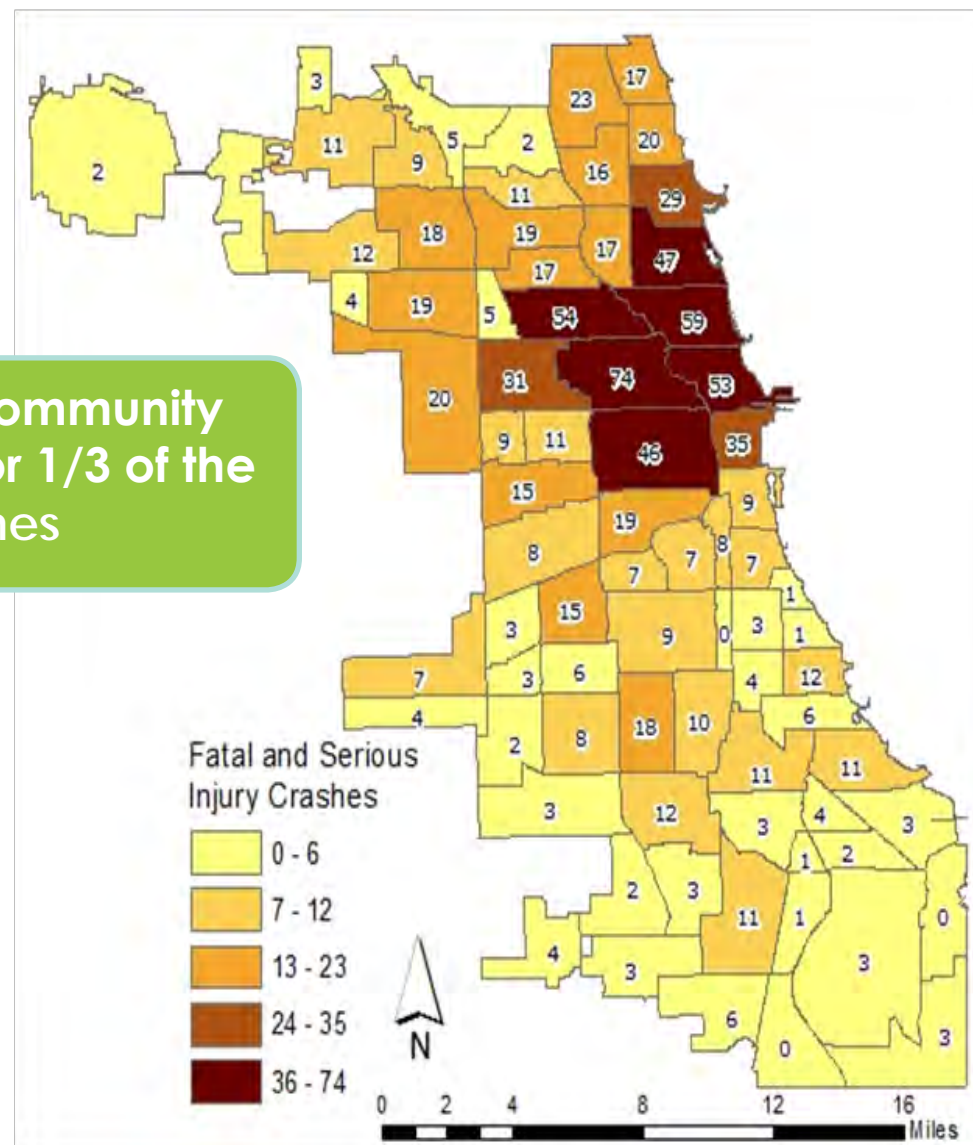


Figure 10: Fatal and serious bicycle injury crashes, 2005 - 2010

The six community areas with the highest number of fatal and serious injury (Type A) crashes also had high bicycle usage. These community areas had 34 percent of fatal and serious crashes and 37 percent of all injury crashes, however they accounted for an estimated 40 percent of the miles bicycled (Table 12).

6 of 77 Chicago community areas accounted for approximately 40% of the bicycle miles traveled

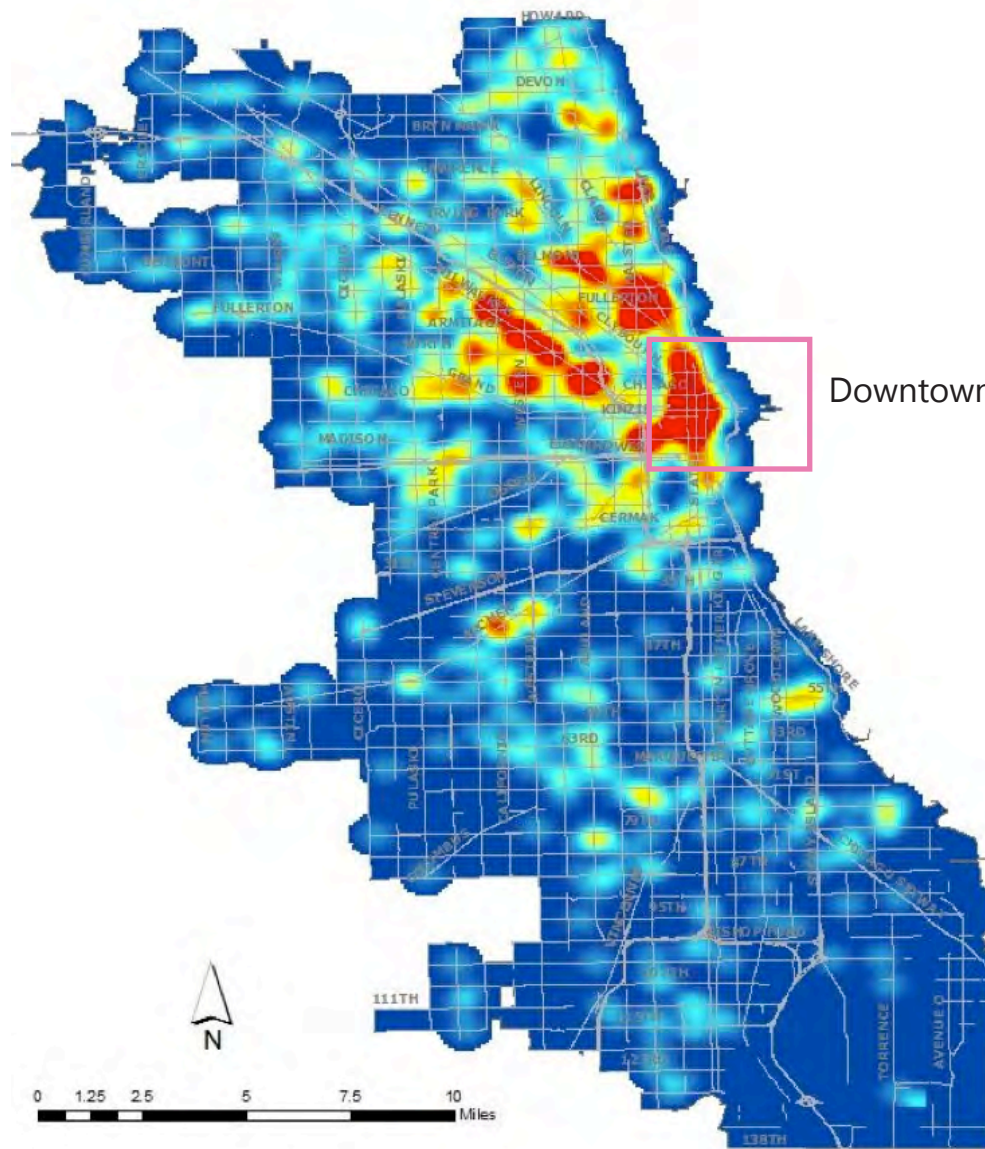
Chicago Community Area (CCA)	Bicycle crashes		Miles / day
	Fatal + Type A	Total	
Total of six CCAs with greatest no. of crashes	333	3,206	129,000
Rest of city	643	5,534	191,000
City total	976	8,740	320,000
Six CCAs as percent of city total	34%	37%	40%

Table 12: Bicycle crashes and miles cycled in the six highest community areas with the most crashes (by crash location; miles by place of residence)





HOT SPOTS



Downtown

The largest concentration of bicycle injury crashes were located within and north of downtown Chicago (Figure 11). There were also large pockets of crashes on primary diagonal streets that serve the Loop area, including Milwaukee Avenue, Lincoln Avenue, and Clark Street. One particular hot spot can be seen where Lincoln and Clark converge. There were also smaller hot spots around the city, such as the pocket in Uptown and on Archer Avenue.

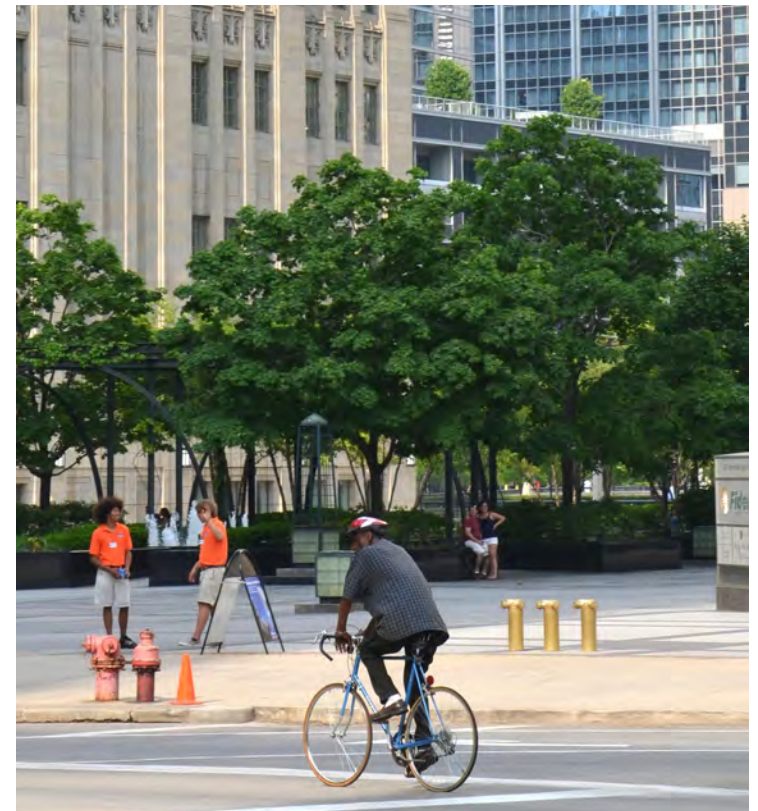


Figure 11: Fatal and Type A injury crash hot spots, 2005-2010

INTERSECTIONS

The majority of bicycle crashes occurred at intersections (Table 10). Approximately 55 percent of bicycle injury and fatality crashes occurred at intersections. The intersections with the highest percentage of bicycle crashes included Halsted, Milwaukee and Fullerton Avenues. Additionally, the intersection of the Lakefront Trail and Montrose Avenue had more than 15 crashes in the study period.

55% of bicycle crashes occurred at intersections, with complex intersections being the most hazardous

Intersection related	Fatal Crashes		Injury crashes	
	Number	Percent	Number	Percent
Yes	18	56.3%	4,813	54.3%
No	14	43.8%	4,048	45.7%
Total	32	100%	8,861	100%

Table 10: Bicycle fatal and injury crashes at intersections

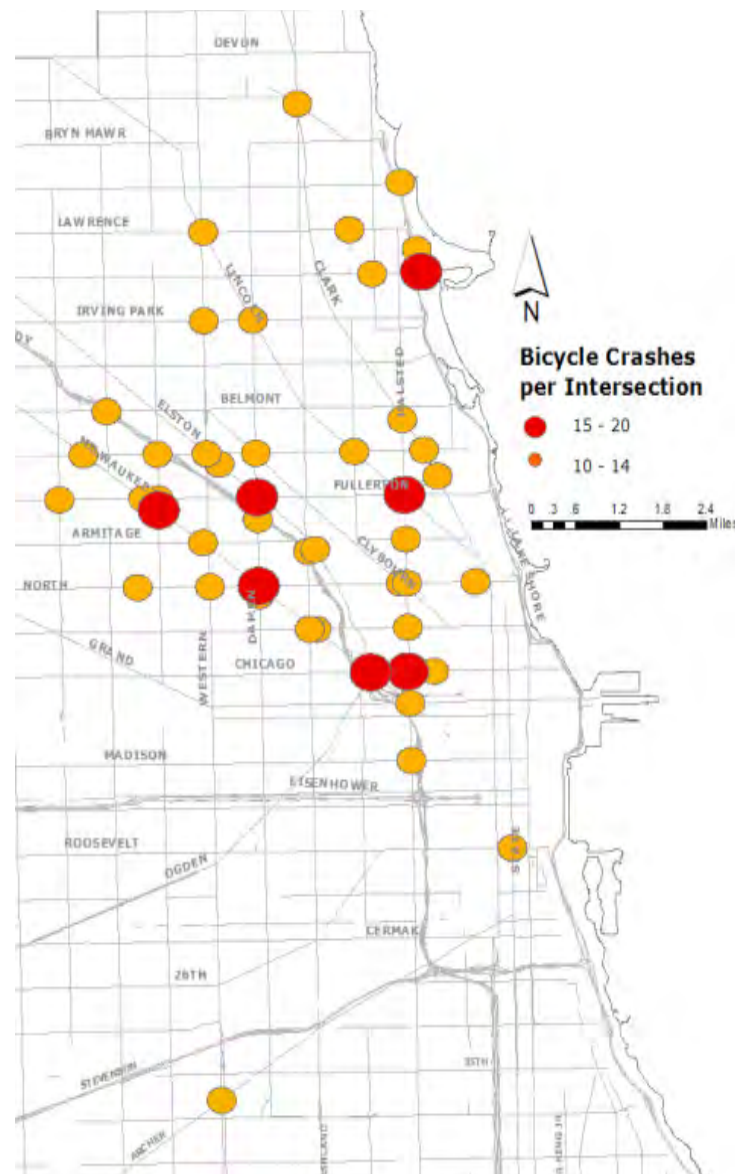


Figure 12: Intersections with large numbers of injury crashes, 2005-2010



NON-INTERSECTION RELATED CRASHES

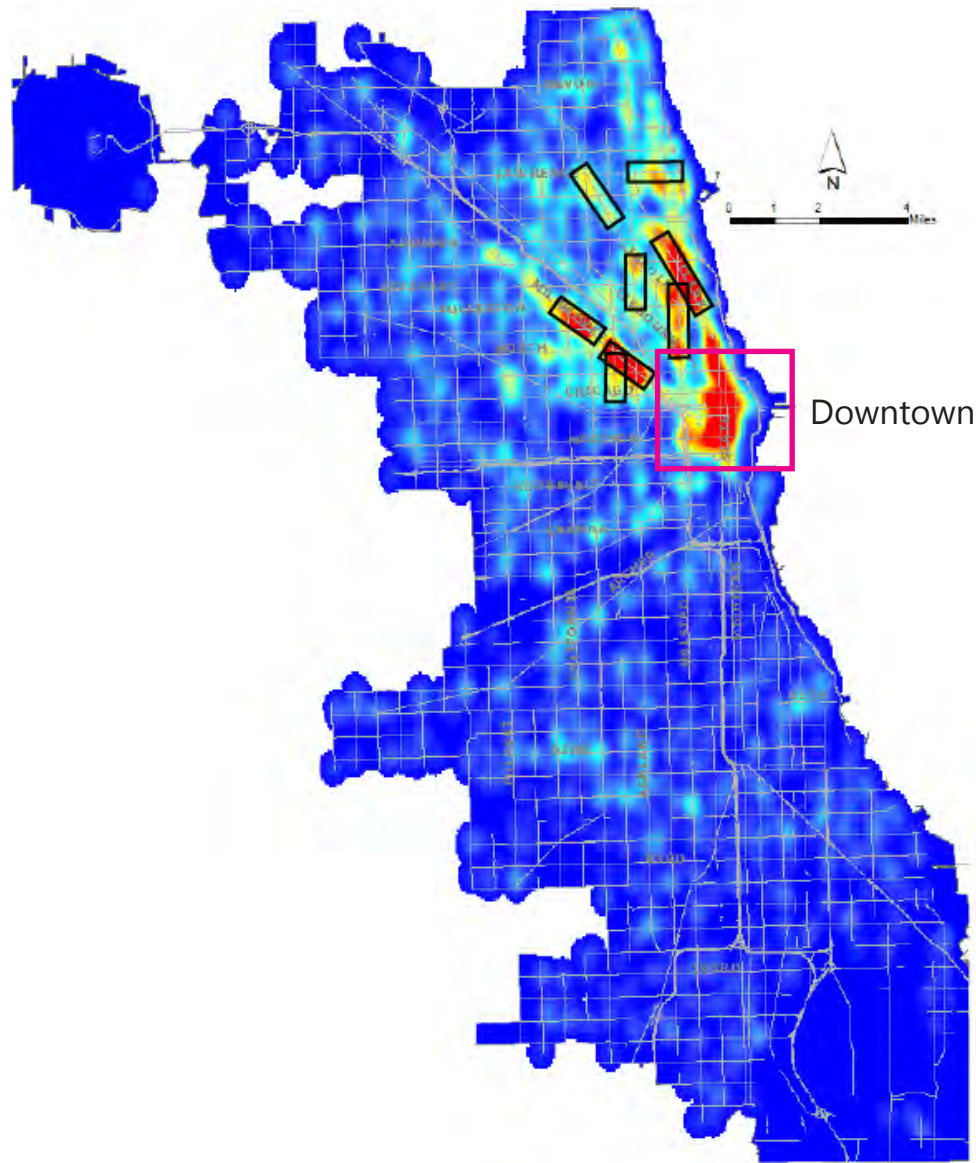


Figure 13: Fatal and injury non-intersection related crashes, 2005-2010

Arterial roadways and local streets had the same number of fatal and serious injury crashes. However, local streets had 46 percent more Type B (non-incapacitating) crashes and Type C (possible injury) crashes than arterials. The lower speeds on local streets may be a factor. See Tables 13 and 14.

Street	From	To	Length (miles)	Crash/Mile
Milwaukee	North	Division	0.7	70.1
Clark	Racine	Fullerton	1.6	48.6
Milwaukee	Fullerton	Armitage	0.7	48.1
Halsted	Diversey	North	1.5	29.9
Damen	North	Chicago	1.0	27.8
Lawrence	Ashland	Sheridan	0.8	25.2
Ashland	Belmont	Fullerton	1.0	15.9
Lincoln	Lawrence	Irving Park	1.1	14.9

Table 13: Crashes identified as non-intersection related, 2005 - 2010



Street	From	To	Length (miles)	Crash/ Mile
Michigan	Lake	Randolph	0.1	76.0
La Salle	Randolph	Calhoun	0.1	60.6
Michigan	Ontario	Superior	0.2	46.4
Halsted	Randolph	Adams	0.4	44.0
Division	Orleans	Clark	0.3	42.0
Kinzie	Clark	State	0.2	38.4
Chicago	Franklin	La Salle	0.2	37.3

Crash severity decreases
with vehicle speed

Table 14: Crashes identified as non-intersection related, Downtown Chicago, 2005 - 2010

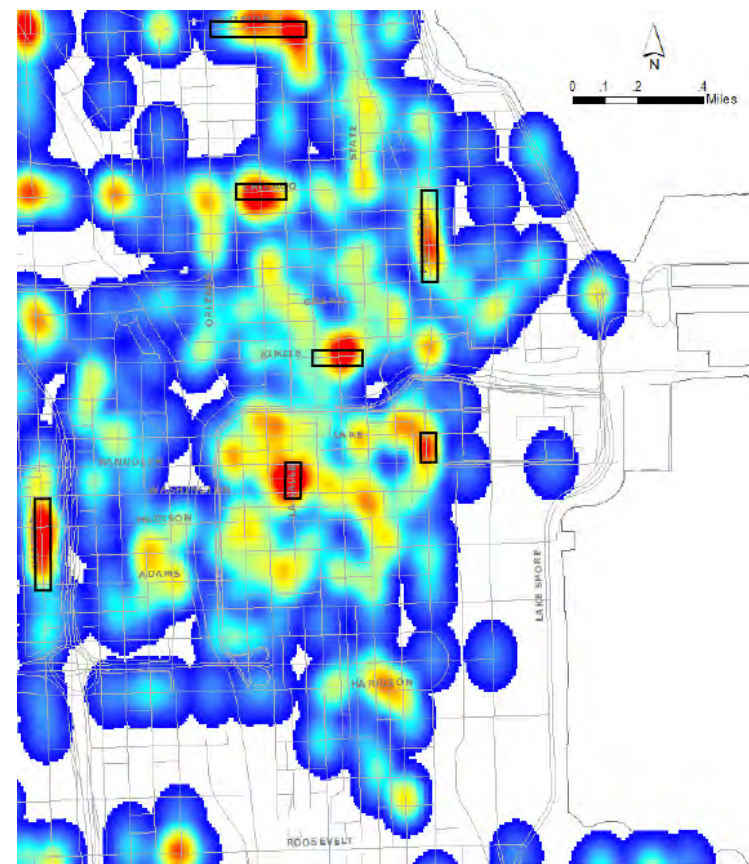


Figure 14: Fatal and injury non-intersection related crashes, Downtown Chicago, 2005-2010



Crash location and conditions

DOORING ON ARTERIAL STREETS

The 15 arterial streets with the largest number of dooring crashes are shown in Table 15. These arterials accounted for 52 percent of all dooring crashes. Table 15 also reveals the number of overall injury and fatal crashes on each of the arterial streets. The ratio in the last column of Table 15 identifies which of the arterials have disproportionately high and low proportion of dooring crashes compared to bicycle injury crashes. The ratio is computed as an effort to account for variations in the amount of bicycle traffic volume on each street. Lincoln, Clark and Milwaukee are the arterials with the highest rates of dooring crashes. Fullerton, Chicago, Western and Ashland Avenues have the lowest ratios. Armitage not on the top-15 list are Armitage with nine and State with six dooring crashes.

Arterial	Fatalities	Injury crashes	Dooring	Ratio*
Milwaukee	0	834	33	4.0
Halsted	0	715	11	1.5
Clark	4	658	28	4.3
Western	4	590	5	0.8
Ashland	2	520	4	0.8
Damen	4	509	19	3.7
North	0	494	7	1.4
Fullerton	0	454	1	0.2
Chicago	5	428	2	0.5
Division	2	367	7	1.9
Diversey	1	350	4	1.1
Belmont	0	332	12	3.6
Lincoln	2	331	20	6.0
California	0	319	5	1.6
Kedzie	4	302	6	2.0

*(Dooring X 100 / Injury crashes)

Table 15: Dooring crashes on the 15 arterials with the higher number of bicycle crashes

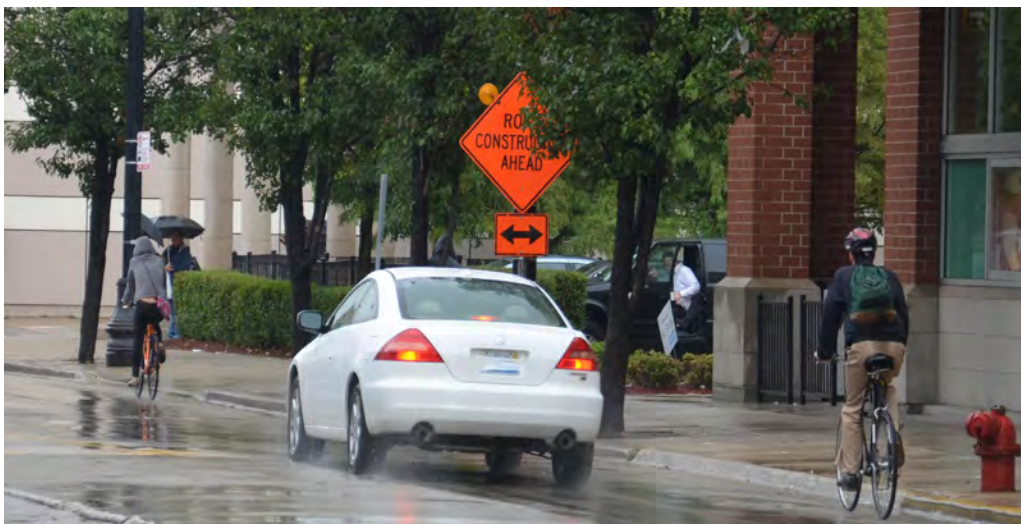


WEATHER, LIGHT AND ROAD SURFACE CONDITIONS

Nearly 90 percent of bicycle crashes occurred when the roadway was dry and the weather was clear (Table 16). However, amount of light was a factor on the percentage of crashes, with 22 percent of crashes and 40 percent of fatalities occurring after sunset.

Condition	Fatal Crashes	Injury Crash Type			Injury Total	Percent Known
		A	B	C		
Weather						
Clear	29	807	3,932	2,939	7,678	89%
Light						
Daylight	17	635	3,269	2,479	6,383	72%
Evening	13	262	948	703	1,913	22%
Road surface						
Dry	29	802	3,875	2,878	7,555	89%

Table 16: Weather, light and road surface conditions during bicycle crashes, 2005-2010



A photograph of two cyclists riding on a city street. The cyclist in the foreground is wearing a white helmet, a blue long-sleeved shirt, and light blue pants, carrying a large grey messenger bag. The cyclist behind them is wearing a white helmet, a white t-shirt, and brown pants. They are riding on a paved street with a crosswalk. In the background, there are multi-story buildings, a traffic light showing red, and a green street sign for N Milwaukee Ave and N Damen Ave. A blue semi-transparent banner is overlaid across the middle of the image with the text "Crash Reduction Strategies" in white.

Crash Reduction Strategies



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A full understanding of the implications of bicycle crash data is the critical first step in improving bicycle safety in Chicago. But in order to reduce bicycle crashes by 50 percent in 5 years, the aim of this report is the identification of strategically focused solutions and countermeasures to reduce crashes, complete with suggestions for implementation. The following set of Strategic Recommendations puts forth key activities for addressing Chicago's top bicycle crash concerns and improving conditions for bicyclists of all ages and abilities.

1 Roadway Design and Engineering Solutions

There has been extensive research conducted in recent years on ways to design, construct and maintain streets for bicycle safety. National resources including the Federal Highway Administration's BIKESAFE project (2006), the National Association of City Transportation Officials' Urban Bikeway Design Guide (2011), as well as the City of Chicago's Complete Streets Design Guide provide excellent technical guidance on facility selection and implementation. With regard to the key findings in this report, the following are recommended as areas for highest prioritization:

- **Implement intersection design improvements at high crash locations:**

55 percent of bicycle crashes in Chicago occur at or near intersections. Designing intersections to encourage correct roadway behavior for both drivers and bicyclists has the potential to dramatically reduce these crashes (SWOV 2010; Summala et al 1996). Possible treatments include:

- Bike boxes*
- Intersection markings including through bike lanes, transitional dashed and colored pavement*
- Combined bike lane/right turn lanes*
- Bike signals*
- Refuge islands*
- Turning restrictions*
- In-street signage*
- Leading pedestrian intervals*
- Lighting*



- **Expand the network of protected bike lanes:** Providing dedicated spaces for bicyclists to ride beyond intersections, especially physically separated on-street bike lanes, has been proven to not only improve safety for cyclists, but for all roadway users (Ewing and Dumbaugh 2009; Marshall and Garrick 2011). The Chicago Bicycle Program is already pursuing the following innovative strategies, outlined in the Streets for Cycling Plan 2020:
 - a. *Separated bikeways*
 - b. *Buffered bike lanes*
 - c. *Marked shared lanes*
 - d. *Neighborhood Greenways*
 - e. *Bike superhighways*
- **Institute traffic calming techniques to slow speeds at the most severe crash locations:** Vehicle speed has been shown to be a key factor nationally in crash severity (Ewing and Dumbaugh 2009; Garder 2004; Zegeer et al 2002); 40 percent of crashes in Chicago occurred due to a vehicle's failure to yield. By designing streets for slower speeds, crash injuries and fatalities can be reduced. The following traffic calming features should be considered:
 - a. *Reduced curb radii*
 - b. *Sight distance improvements*
 - c. *Sidewalk bump outs*
 - d. *Speed tables or humps*
 - e. *Reducing and/or narrowing vehicle travel lanes*





2 Education and Marketing Solutions

Unlike infrastructure solutions, education and marketing strategies lack a comparable level of research that illuminate effective programs and best practices. Raising awareness around crucial safety issues for motorists and bicyclists will improve interactions among these users and enhance the safety of roadway environments (Mineta Transportation Institute 2012, Ch. 7). The CDOT Bicycle Program is nationally renowned for having the longest-running Bicycle Ambassador Program in the U.S. The Bicycle Program is encouraged to research models of social behavior change and successful case studies in other cities in order to enhance the impact of these efforts (City of Chicago 2012a; Mineta Transportation Institute 2012, Ch. 7; Bandura 2004).

- **Expand Targeted Enforcement Outreach:** Directly engaging drivers and bicyclists with safety messages while they are in the traffic environment is an important strategy for targeting dangerous roadway behaviors. Issuing citations and warnings for dangerous behavior can lower the potential for crashes. With the continued cooperation of the Chicago Police Department and aldermanic offices, these efforts may be expanded to include:
 - a. *Targeted education and outreach activities at locations with disproportionately high numbers of bicycle crashes*
 - b. *Outreach targeting specific driver and bicyclist errors most highly implicated in crashes, including:*
 - *Motorist failure to yield*
 - *Bicyclist crossing against the signal*
 - *Bicycling without a helmet*
 - *Bicycling at night without front or rear lights*
 - *Taxi/bicyclist interactions*



- **Expand commercial operator training:** CDOT's current training programs for taxi drivers, CTA bus operators and the Chicago Police Department have been effective in delivering education about bicycle-related laws and procedures (City of Chicago 2012a). Yet taking into account the high proportion of crashes involving taxis, and the growing number of crashes involving large vehicles, there is room for improvement. Education for all commercial operators could be made mandatory; including all City of Chicago vehicle operators and hired car service drivers.



- **Promote Enhanced Driver Education:** Driver education programs allocate little attention to sharing the road with bicyclists and pedestrians (Chicago Public Schools 2011, Illinois Driving School 2012), yet cyclists aged 16-24 make up the largest age group of bicycle crashes. Supplementing standard

driver education with this information will help prepare new drivers to operate safely on and off bikes.

- **Create broad reaching marketing campaigns targeting high risk behaviors and road users:** Large-scale media campaigns can be effective in educating the general public about the costs and casualties of traffic crashes. The age group that makes up the largest number of crashes involving bicycles in Chicago is 16-35, which is the primary age group targeted for most media advertising on television and online. New York City's "Biking Rules" and Chicago's recent "It's Up to You" pedestrian safety initiative are examples of wide-reaching, multi-faceted campaigns that effectively increase understanding of this issue (Transportation Alternatives 2012; City of Chicago 2012c).

- **Enhancement direct motorist and bicyclist education programs:** With the planned increase in bikeways installation citywide, motorists and bicyclists both will require additional education to learn to safely share the road. Enhancement could include:

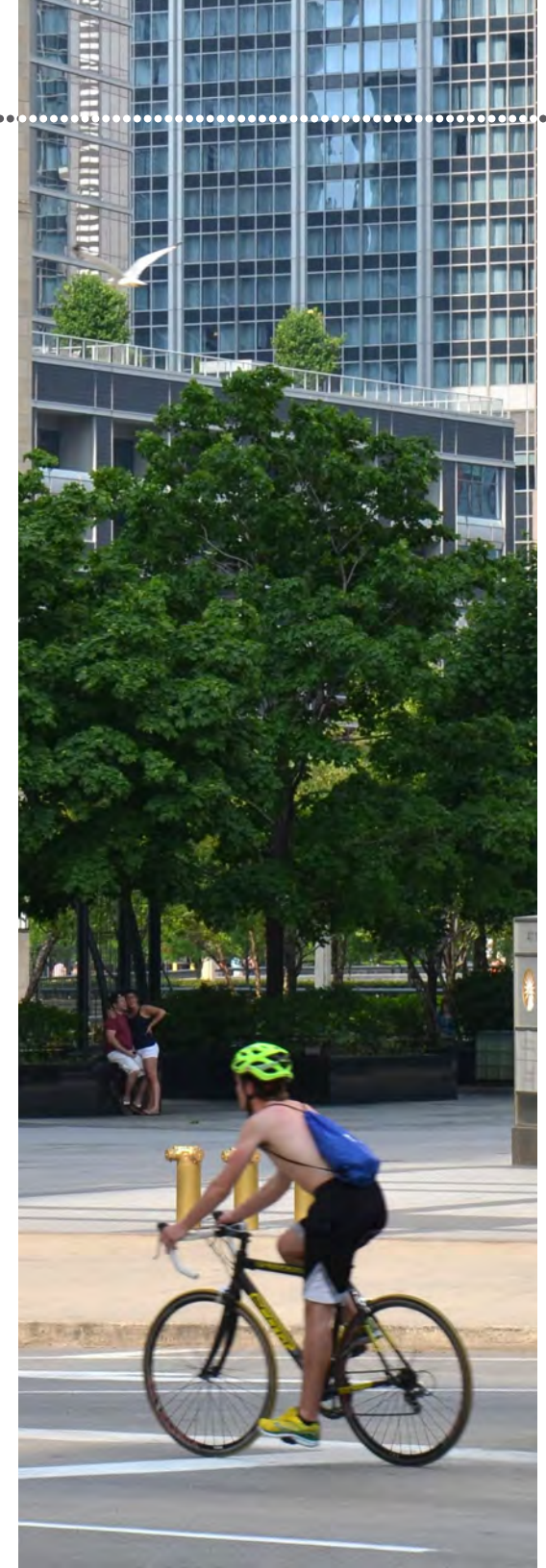
- Increase opportunities for on-bike and traffic cycling instruction*
- Increase opportunities for routine and repeated exposure to safety messaging*



3 Data and Reporting Solutions

A consistent challenge faced by transportation professionals and researchers alike, particularly with regard to non-motorized modes, is a lack of availability of comprehensive data. Ridership levels depict bicyclists' relative exposure to potential crashes, which in turn provides perspective to overall crash rates. Drawing firm conclusions from crash data without comparably reliable exposure data may lead to flawed assumptions. The Chicago Bicycle Program has begun recording location-specific ridership data including monthly counts at 6 sites just outside the central business district, and quarterly cordon counts at locations entering and exiting the Loop (City of Chicago 2012b); however, this information is not available for the study period. Mechanisms for the collection of a variety of data types should be developed to enable a holistic impression of the bicycle crash environment.

- **Collect comprehensive, multi-year bicycle counts:** Having reliable bicycle usage and exposure data is an absolute necessity for a complete understanding of crashes in Chicago (Klop and Khattak 1999). The crash analysis in this report is limited without the ability to consider bicycle ridership levels. The Chicago Bicycle Program could consider emerging automated bike count technologies as they become available. Bike counts should be controlled for location, time of year, time of day and weather conditions. Focus where possible, should be placed on priority intersections and roadway segments.



- **Develop mechanisms for collecting non-motor vehicle related crash data:** The data analyzed in this report do not include non-motor-vehicle-related crashes, such as pedestrian/pedalcycle crashes. While these types of crashes may not often result in severe injuries or fatalities (Chong et al 2009), they may comprise a larger percentage of overall crashes than do motor vehicle-related crashes in Chicago. Specifically crashes occurring on the Lakefront Trail, on sidewalks and other off-road facilities are in need of analysis and countermeasures.



- **Regularly update and publish bicycle crash data and improvement strategies:** Conducting this type of analysis on an annual basis will allow the CDOT Bicycle Program to gauge changes in crash factors and issues in order to better focus safety resources. Objectives should include:
 - Producing a comprehensive bicycle crash report every 5 years*
 - Expanding future analysis to correlate traffic speed and volume data with crashes*
- **Develop and implement outcome evaluations for non-infrastructure programs and initiatives:** There is little available published data on the impact of bicycle safety education programs (Mineta Transportation Institute 2012, Ch 4). Equally important to understanding roadway design implication on crashes is the ability to assess non-engineering strategies to gauge their effectiveness. Partnering with a qualified research institution on developing an objective evaluation plan for programmatic work will help in making informed investments in these important strategies.



4 Enforcement Solutions

- **Improve police reporting for fatal and serious injury crashes:** While the majority of reports completed by the Chicago Police Department for bicycle-related crashes are thorough and informative, a small number of important data categories are often incomplete or inadequate. Specifically, improve reporting regarding:
 - a. *Motorist and bicyclist impairment*
 - b. *Motorist and bicyclist distraction, including cellphone use*
 - c. *Helmet use*
- **Increase targeted bike lane enforcement actions:** When motor vehicles park or drive in a marked bike lane, bicyclists are forced to ride into the vehicle travel lane, putting them at increased risk for crashes (Reynolds et al 2009). Similarly, bicyclists must stop for pedestrians in crosswalks, especially when crosswalks intersect bike lanes. Considering Chicago's ambitious goals for installation of new bikeways, these types of violations may increase. For these reasons, targeted enforcement for both motorists and bicyclists at strategic locations (like crash hot spots and new bikeway facility installations) is recommended, using a phased approach of publicity first, followed by warnings and finally citations.



5 Policy Solutions

- Improve inter-agency partnerships and collaboration:** The Mayor's Bicycle Advisory Council has long provided a forum for citizens and Bicycle Program staff to share updates, exchange ideas and express concerns (City of Chicago 2012d). This concept should be expanded to include a venue for routine inter-agency coordination on issues that relate to bicycle safety. Participating agencies include the Chicago Park District, Office of Emergency Management and Communications, Chicago Police Department, Department of Business Affairs and Consumer Protection and Department of Housing and Economic Development.
- Implement Chicago's Complete Streets Policy and Children's Safety Zone Policies:** The passage of Chicago's Children's Safety Zone Ordinance and adoption of a holistic Complete Streets Policy are important first steps in prioritizing the safety of the City's most vulnerable citizens (City of Chicago 2012e). To realize their full efficacy, good policies must be implemented in a thorough and timely manner. This will complement many recommendations in this report.





Countermeasures Matrix

		Solutions											
		Design			Education					Enforcement		Policy	
		Creative intersection design	Protected bikeways	Traffic calming	Ambassador programs	Share the road outreach	Public awareness marketing campaigns	Commercial operator training	Expanded driver education	Improved police reporting	Bike lane targeted enforcement actions	Inter-agency partnerships	Child Safety Zones
Crash Factors	Driver failure to yield	X	X	X	X	X	X	X	X	X	X	X	X
	Bicyclist crossing against signal	X	X		X	X	X	X	X	X		X	X
	Intersection crashes	X	X	X	X	X	X	X	X	X	X	X	X
	Dooring		X		X	X	X	X	X	X	X	X	
	Nighttime crashes	X	X	X	X	X	X		X	X		X	X
	Lack of helmet use				X	X	X		X	X		X	
	Driver and bicyclist impairment				X	X	X	X		X		X	X
	Taxi crashes				X	X	X	X		X		X	X

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REFERENCES

- Bandura, Albert. 2004. Health Promotion by Social Cognitive Means. *Health Education & Behavior*, Vol. 31 (2): 143-164 (April 2004).
- City of Chicago. 2012a. Chicago Department of Transportation: Chicago Bicycle Program. <http://www.chicagobikes.org/> (accessed August 22, 2012).
- . 2012b. Chicago Department of Transportation: Chicago Bicycle Program. Bicycle Counts. <http://www.chicagobikes.org/public/bikecounts.php> (accessed August 22, 2012).
- . 2012c. Chicago Pedestrian Safety Campaign. About the Campaign. <http://chicagopedsafesafety.org/aboutcampaign> (accessed August 23, 2012).
- . 2012d. Bike Plan 2015 City of Chicago. Mayor's Bicycle Advisory Council. <http://www.bike2015plan.org/mbac/index.html> (accessed August 23, 2012).
- . 2012e. Office of the City Clerk: Legislative Information Center. Establishment of Children's Safety Zones program. <http://chicago.legistar.com/Legislation.aspx> (accessed August 21, 2012).
- Chicago Public Schools. 2011. Driver Education. http://www.cps.edu/Programs/Before_and_after_school/Pages/DriverEducation.aspx (accessed August 23, 2012).
- Chong, Shanley, Roslyn Poulos, Jake Olivier, Wendy L. Watson and Raphael Grzebieta. 2010. Relative injury severity among vulnerable non-motorized road users: Comparative analysis of injury arising from bicycle-motor vehicle and bicycle-pedestrian collisions. *Accident Analysis and Prevention* 42 (2010) 290-296.
- Ewing, Reid and Eric Dumbaugh. 2009. The Built Environment and Traffic Safety: A Review of Empirical Evidence. *Journal of Planning Literature*. Volume 23 Number 4 May 2009 347-367.
- Federal Highway Administration. 2006. BIKESAFE: Bicycle Countermeasure Selection System. What is BIKESAFE. <http://www.bicyclinginfo.org/bikesafe/> (accessed August 22, 2012).
- Forsyth, Ann and Kevin Krizek. 2010. Promoting Walking and Bicycling: Assessing the Evidence to Assist Planners. *Built Environment*. Vol 36 No 4. (2010) 429-446.
- Garder, P. E. 2004. The impact of speed and other variables on pedestrian safety in Maine. *Accident Analysis and Prevention* 36 (4): 533-42.
- Illinois Driving School. 2012. Illinois Driving School: Classes. <http://www.illinoisdriversed.com/index.htm> (accessed August 23, 2012).
- Jacobsen, P.L. Safety in numbers: more walkers and bicyclists, safer walking and bicycling. 2003. *Injury Prevention*. 9:205-209.
- Klop, Jeremy and Asad Khattak. 1999. Factors Influencing Bicycle Crash Severity On Two-Lane Undivided Roadways In North Carolina. Washington D.C.: Transportation Research Board 78th Annual Meeting.
- Marshall, Wesley E. and Norman W. Garrick. 2011. Evidence on Why Bike-Friendly Cities Are Safer for All Road Users. *Environmental Practice*. 13 (1) March 2011.
- Mineta Transportation Institute. 2012. Report 11-08: Promoting Bicycle Commuter Safety. San Jose, CA: San Jose State University.

National Association of City Transportation Officials. 2011. Urban Bikeway Design Guide. April 2011 Edition. <http://nacto.org/print-guide/> (accessed August 21, 2012).

Reynolds, Conor CO, M Anne Harris, Kay Teschke, Peter A Crompton and Meghan Winters. 2009. The impact of transportation infrastructure on bicycling injuries and crashes: a review of the literature. *Environmental Health*. 8:47.

Summala, Heikki, Eero Pasanen, Mikko Rasanen and Jukka Sievanen. 1996. Bicycle Accidents and Drivers' Visual Search at Left and Right Turns. *Accident Analysis and Prevention*. Vol. 28, No. 2, pp. 147- 153, 1996.

SWOV. 2010. SWOV Institute for Road Safety Research. SWOV Fact Sheet: Bicycle facilities on distributor roads. Leidschendam, the Netherlands: December 2010. http://www.swov.nl/rapport/Factsheets/UK/FS_Bicycle_facilities.pdf (accessed August 22, 2012).

Transportation Alternatives. 2012. Biking Rules: A New Street Code for NYC Cyclists. <http://bikingrules.org/> (accessed August 28, 2012).

Zegeer, C. V., C. Seiderman, P. Lagerwey, M. Cynecki, M. Ronkin and R. Schnieder. 2002a. Pedestrian facilities users guide—Providing safety and mobility. Report No. FHWA-RD-102-01. Washington, DC: Federal Highway Administration.



